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So many requests are received from abroad for parts of the "Agricultural Journal" which were never published that the following list of all issues published and those which are not now available is given for reference. Attention is especially directed to Volume 7 which had only one part :—

Vol.			Vol.		
1.	3 numbers,	1928.	13.	4 numbers,	1942.
2.	4 ,,	1929.	14.	4 ,,	1943.
3.	3 ,,	1930 (none).	15.	4 ,,	1944.
4.	4 ,,	1931.	16.	4 ,,	1945.
5.	2 ,,	1932 (none of No. 2).	17.	4 ,,	1946 (none of No. 1).
6.	2 ,,	1933.	18.	4 ,,	1947 (none of No. 1).
7.	1 ,,	1934.	19.	4 ,,	1948 (Nos. 3 and 4 form a double issue).
8.	4 ,,	1935-7 (none of No. 4).			
9.	4 ,,	1938 (none of Nos. 2, 3 and 4).	20.	4 ,,	1949.
10.	4 ,,	1939 (none of Nos. 2 and 4).	21.	3 ,,	1950 (none of Nos. 1 and 2 combined).
11.	4 ,,	1940 (none)			
12.	4 ,,	1941 (none of Nos. 1 and 2).	22.	1 ,,	1951.

ISSUES OF AGRICULTURAL CIRCULAR

NUMBERS and year of issue of the "Agricultural Circular" :—

Vol. 1, 1920, 12 numbers. Vol. 4, 1923, 1 number.
2, 1921, 5 ,, 5, 1924-5, 2 numbers.
3, 1922, 4 ,,

As number 4 of Vol. 3 was printed as "Volume 4" and number 1 of Vol. 4 as "Volume 5" it would appear from an inspection of a complete set that Volume 4 comprised only a number 4 and that there were two issues of Volume 5, No. 1.

ANNUAL BULLETINS

THE Annual Bulletin of Divisional Reports ran from 1931 to 1938 and was then discontinued.

OLD ISSUES OF AGRICULTURAL BULLETINS

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No. 1. Sisal Hemp in Fiji, 1911.
3. Rhinoceros Beetle in Samoa, 1912.
4. The Banana in Fiji, 1912.
5. Scale Insect on Bananas, 1913.
6. Lemon Grass, 1913.
7. A Mission to Java for a Coleopterous Pest of Bananas, 1914.
8. Coconut Experiments, 1915.
9. Soils of Fiji—I, 1916.
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12. Leaf Moth of Coconuts, 1919.
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25. Observation on Copra Drying and Copra Dryers, 1950. Price 1s. 6d.

Applications should be made to the Librarian, Department of Agriculture, Suva, Fiji.

—EDITOR

Agricultural Journal

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EDITORIAL . . .

ECONOMIC DEVELOPMENT

During 1953 the Report of the Economic Review Committee was published (1), and later many if its recommendations relating to Agricultural development were endoresed by the Legislative Council. Many of these have already been put into effect: An aerial survey party continued the survey of the Colony—funds have been provided to purchase Santa Gertrudis bulls, and for the enlarged poultry project at the Principal Agricultural Station.

To encourage and support agricultural education, the Navuso Agricultural School is being assisted and funds have been made available for a number of agricultural bursaries. Substantial additions to the extension establishment of the Department have been approved.

In the Northern Division a district farm is to be developed at Labasa, and a demonstration area in Savusavu or at Natewa Bay is to be established in order to show how a coconut plantation can be grassed for cattle production. It is intended also to establish a small experiment station where work on fertilizers, cover crops and selection of coconuts can be undertaken. The sum of £20,000 has been suggested for capital development. Attention is also being directed to the prospects of Cacao planting in the islands of Vanua Levu and Taveuni.

In Viti Levu the reconnaisance Soil Survey was carried forward during the year and it is hoped that this will be extended to cover Vanua Levu.

In Viti Levu also, special arrangements have been made for engineering surveys of the Navua-Deuba flats, the Toga swamp and mangrove swamp areas which may be capable of drainage and irrigation development. Soil Surveys of Navua and Toga areas have been completed. The object of these investigations is to increase the production of rice by bringing into cultivation some 19,500 acres of new land. Investigations have been instituted into mechanization of rice planting and harvesting; and the Department's work with a machinery pool has been endorsed with proposals for further expansion.

A study has been made of the prospects of extending the banana industry to Lomaiviti, Savusavu and Kadavu. At this time, after several years in abeyance, the shipment of bananas from Kadavu has been commenced. At Suva wharf a temporary shelter for fruit has been constructed and preliminary arrangements made for installation of experimental cool storage facilities.

The Agricultural research projects under the Development Plan have made good progress. Biochemical investigations concerned with the nutritive value of local grasses and fodders have commenced; the Plant Pathologist assumed duty on the 10th July, 1953, and the Botanical laboratory and Herbarium which is situated in Suva was completed during the year.

The work of vegetative propagation of cacao, as well as the raising of seedlings, is well advanced at Naduruloulou-where some 10.000 plants will be produced during 1954. The first of a series of observation plots has been planted out on Fijian land; and many new and valuable cacao plants introduced from Trinidad, Samoa and Papua New Guinea.

The Grass Seed Production Farm at Ra has overtaken the demand for grass and legume seeds—adequate supplies of Batiki blus grass and *Centrosema* are now available for distribution.

The Report made many important recommendations and exhortations concerning land and stressed the need for replanning and for the Fijians to develop their land resources more effectively.

Readers who are interested in the present and future trends of economic development in the Colony are referred for information to the Report of the Economic Review

Committee and to the Annual Report of the Department of Agriculture for the year 1952 (2)—Both of these documents contain much valuable information which is not available elsewhere.

REFERENCES.

(1) Report of the Economic Review Committee 1953, C.P. No. 12, 1953, 29 p.p., price 2s. 6d.

(2) Annual Report of the Department of Agriculture, Fiji, for 1952. C.P. No. 33, 1953, 61 pp., price 5s. 6d.

NOTES RE SHIPS FROM SAMOA AND TONGA CALLING AT SUVA

Ships that have called at ports infested with Rhinoceros beetle within twenty days of their arrival at Suva are subject to certain conditions on arrival.

They are inspected most carefully by officers of the Department of Agriculture who pay particular attention to vegetable lockers and other dark places in which the beetle might hide.

Holds, containing cargo loaded in infested ports, are only allowed to be opened during the hours of daylight in Suva and then only after permission has been requested from and granted by the Director of Agriculture or inspector appointed by him. A ship that does wish to work at night a hold containing cargo from infested ports may do so providing the vessel moves out to an appointed anchorage in the centre of Suva harbour and remains there during the hours of darkness.

Ships that have been in the ports of Vavau and Pago Pago during the hours of darkness are only allowed alongside Suva wharf in the day time and must move out into the stream at sunset and remain there at anchor, and work may continue at night.

Because vessels that call at Apia do not lie alongside the land but are separated from the land by several hundred yards of sea it is felt that there is less chance of them being visited by a flying beetle at night and are consequently allowed to remain alongside the Suva wharf at night.

Small vessels from Vavau or Pago Pago which carry no passengers or cargo, such as naval sloops or frigates, are more easily searched. Following an absolute search such vessels may be allowed to remain alongside the Suva wharf overnight at the discretion of the Director of Agriculture.

All vessels must store away to the satisfaction of the inspector any fruit such as bunches of bananas, pineapples, etc. Frequently members of a ship's crew have bunches of fruit hanging on the after deck.

Neither passengers nor crew of a visiting vessel are permitted to bring any plant material, such as roots, cocoa pods, coconuts, citrus, etc, ashore in Fiji. The same ban applies to coconut leaf baskets which could quite easily have a live beetle secreted in them.

—C.R.V.

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Small number of day old chicks are available at £8 per 100 unsexed.

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AGRONOMY . . .

PADI PLANTING IN VANUA LEVU

BY S. BHARAT

Ten years ago notes on a report of padi plantings in Vanua Levu by M. D. ffrench Mullen appeared in the Agricultural Journal(1). *It is of interest to compare this season* 1952/53 *with that of* 1942/43. (*See tables* I *and* II). *Some attempt has been made to trace and account for the changes that have taken place ; but to a large extent the growth of the rice industry has been due to the gradual expansion and development that has taken place in Vanua Levu over the last decade.*

With the enforcement of the Trespass Ordinance, income from goat rearing and cattle farming for the majority of the farmers was reduced because holdings were small and sufficient grazing land was not available. Farmers disposed of their surplus stock at low prices ; and as a consequence, in time prices of goats and working bullocks went up. The introduction of tractors, has checked the rise in prices of working animals in the cane areas, and this has had a balancing effects for farms in non-cane-growing areas. Nevertheless the need to secure an alternative source of income has led to an expansion in padi planting, which has been encouraged and extended by good prices prevailing in the past few seasons.

To-day, the principal cash and food crop of the Indian peasant farmers in the Province of Bua, and of the majority of the Indians living in the area between Nasarowaqa and Tabia in the Province of Macuata, is padi.

Ten years ago Motka was the most popular padi variety and the area was 2,590 acres, which was 71.33 per cent of the seasons' crop. (See table IV). This variety was favoured because of its good yields and excellent milling qualities. Besides it was a late variety, and transplanting was continued till March. It was ready to harvest after the other varieties of padi had been harvested, and it was therefore convenient for the farmers to plant as their main variety.

To-day, Ram Cajara, an imported variety from British Guiana has taken the place of Motka. The main reason for the change in popularity is the susceptibility of Motka to " Rice Yellows " a disease believed to be caused or transmitted by Leaf Hoppers. This disease was first recorded in 1938. In some seasons and in some localities the disease is so severe that the whole of the Motka crop is destroyed ; the stems in a stool rot to root level. Sometimes a number of stems in a stool survive and produce grain ; but when this is milled, the colour of the rice instead of being white is red and the demand for this rice is limited.

Ram Cajara, is a heavy yielder with good milling qualities and is more resistant to " Rice Yellows " ; but, the planting and harvesting periods are the same as for other varieties, and consequently farmers have to complete the work in a limited time. A further disadvantage of this variety is the heavy lodging that takes place when the grain matures. Attack by weevils in the stored grains also appears to be heavier than in Motka.

During the 1947/48, 1948/49, 1949/50 seasons New Guinea became the most popular variety but to-day ranks third to Ram Cajara and Motka. This change was due to a dislike of the uneven ripening of the seed heads of New Guinea even though yields were good.

During the war years Government controlled the sale of rice to non-Asiatics and this continued for some years after the war. The exports of Vanua Levu padi without permits was prohibited and the price of padi was controlled. The phenomenal rise of copra prices, led to a blackmarketing by dealers in rice and the price was substantially above that fixed by the Government. There was increased consumption of rice by Fijians and others. Price controls on padi and rice were lifted in 1950 and restrictions on the export of padi were removed.

Table III presents information comparing padi planting in Vanua Levu for the seasons from 1942/43 to 1952/53.

The most noticeable fact is that the area under rice has almost doubled. The interest shown by the Fijians increased steadily and now they are planting five times as much rice as before. The larger area farmed by the individual is probably due to the fact that he now plants more of his crop by drilling or broadcasting and so has reduced the labour involved. (See table II).

REFERENCE.

1. C.H.: Notes on Padi Planting in Vanua Levu. *Agric. Journal*, Vol. 14, p. 98, December, 1943.

TABLE I.

PADI AVERAGES BY PROVINCES AS COMPARED WITH 1942/43.

Provinces	1942/43 acres	1952/53 acres	Increase acres	Percentage Increase
Macuata	2,346	3,584	1,238	53
Bua	900	1,540	640	71
Cakaudrove	385	603	218	57
Total	3,631	5,727	2,096	Average 60
C.S.R. Co. Tenants	1,231	3,728	2,497	202·84
Grand Total	4,862	9,455	4,593	94·48

TABLE II.

AVERAGE BY GROWERS.

1942/43		1952/53		1942/43	1952/53
No. of Growers	Area	No. of Growers	Area	Average acreage per Grower	Average acreage per grower
Indians 961	3,555 acres	1,241	5,213·6 acres	3·75	4·2
Fijians 39	76 acres	98	398·2	2·0	4·06
Others	.....	11	116·0	.....	10·45
Total 1,000	3,631 acres	1,350	5727·8 acres	.....	.....

TABLE III.

PADI ACREAGES BY PROVINCES.

	1942/43 Acres	1943/44 Acres	1944/45 Acres	1945/46 Acres	1946/47 Acres	1947/48 Acres	1948/49 Acres	1949/50 Acres	1950/51 Acres	1951/52 Acres	1952/53 Acres
Macuata	2,346	2,843·1	2461·8	2724 8	2,222	3,331	3,544	3,372	3,286	3,767	3,594
Bua	900	959 2	947·3	854·1	885	962	1,257	1,207	974	1,255	1,540
Cakaudrove	385	918 0	293·5	444 8	433	424	387	438	428	490	603
Total	3,631	4320 3	3702 6	4023·7	3,540	4,717	5,188	5,017	4,688	5,512	5,737
C.S.R. Co's Tenants	1,231	not av.	not av.	not av.	2,271	2,872	3,175	2,999	2,453	2,802	3,728
	4,862	.....	.....	.....	5,811	7,589	8,363	8,016	7,141	8,314	9,455

TABLE IV.

RICE VARIETIES.

1952/53		ac.	1942/43	ac.
Ramcajara ..	4,066	1st	.....	
Motka	1,692	2nd	2,590	1st
New Guinea ..	1,679	3rd	.....	
Karia	317	4th	95	5th
Patna	316	5th	492	2nd
China Patna ..	312	6th	242	3rd

POTATO SEED

High quality seed potatoes are known as certified seed.

When planting potatoes there are many reasons for using only certified seed. Ordinary tubers used for seed may not germinate well or they may not be of good producing types. What is more serious, they may contain a high proportion of disease. Virus diseases in particular are carried in the tubers and some of them cannot be detected by examination of the seed. That is to say, a tuber which looks quite sound may carry leaf roll or other virus disease. The plant developing from such seed will be affected with the disease and the yield reduced, perhaps as much as one half.

The only reliable good seed is certified seed. This is the seed from crops grown under the supervision of the Government of the country of origin. The crops are inspected at intervals while they are growing and diseased plants removed. Only the best seed is used for these crops and great care is taken in harvesting, grading, labelling and sealing. The result is thoroughly reliable seed. The use of certified seed does not, of course, ensure that the crop grown from it will be free from all diseases. Some diseases are carried in the soil, others in the air, and there is still a possibility that one of these can infect the crop whatever seed is used. It is best, however, to avoid as much disease as possible by the use of certified seed.

—R.B.M.

RECORD BANANA SHIPMENT

When the *Matua* sailed from Suva on the 20th February, 1953, there were on board 20,572 cases of bananas from Fiji.

This was the largest shipment made from Fiji since grading came into effect in 1939. The previous record shipment was made in November, 1948, when 17,505 cases were lifted, also by the *Matua*.

The fruit came from all districts and was considered by all who saw it to be some of the best that had gone from Fiji for very many years.

It included 124 cases loaded in Lautoka, the first time that fresh fruit has been exported on a commercial scale from the Western district.

—C.R.V.

BANANA LICENCE AREAS

For the first time bananas were exported from Lautoka when the M.V. *Matua* called at that port in February, 1953.

As fruit had not been handled in that area before a new banana licence area was proclaimed. The Viti Levu West area comprises the Province of Ba in Viti Levu (excepting the villages of Tore, Rararua and Narata which are in the Sigatoka licence area), the Yasawa Islands and also the island groups of Mamanuca and Malolo which are in Nadroga-Navosa Province.

Messrs. W. L. D. Harvie and Co. of Lautoka applied for and were granted this licence area by the Banana Board.

The first shipment of 124 cases was drawn from the Yasawas and the mainland. Subsequent shipments have been a little larger and the shippers are confident that when the Fijians become accustomed to growing and packing bananas for export, a trade that is entirely strange to them, the industry will expand. The firm is planting up a considerable number of bananas in the Nadi area, from which it is hoped to supply material for further plantings.

—C.R.V.

THE ISLANDS OF ONO-I-LAU

BY. C. WALKER

FOOD CROPS.

All the usual varieties found in other parts of Fiji—individuals or families have plots sufficient for their needs.

TAPIOCA.

This is the most common food crop and "Vula Tolu" is the commonest variety of it. A common practice is to replant with tapioca the hills from which kumala has just been dug. If there is enough mataqali land, or land is given by a mataqali with surplus land, the area is then left fallow for a year when the tapioca is pulled up. However if no land is available the area is used until quite exhausted.

KUMALA.

All the local varieties are present and the tops are used extensively as a green vegetable.

DALO.

Not very much is grown and is confined to a small wet area. Other varieties (Dalo ni Tana and Via) are also present.

YAMS.

An excellent crop was obtained last season and most had planted this season's crop when we arrived. Taniela, Fotuna, Jamani, etc., are common varieties encountered. Unfortunately the group (in fact all Lau) has had no rain for quite a spell, and if it continues most of the food crops will suffer severely. Kawai is third to tapioca and kumala in quantity and rather larger tubers were seen in comparison to last season's Naduruloulou crop. Like the yams most had been replanted and no planting material was obtained—the Buli promised to send some next season.

BANANAS.

Veimama leka, Vudi (including a brown or "red" skinned var.) are present. Banana scab is present and often is very bad.

CITRUS.

Sweet orange, lemon and lime—all the trees seen were canker free.

MANGO.

Trees were in full bloom and some fruit matured. There are only two varieties present, the common small fruit var. and the long fruit (Samoa or carrot) var. found on Doi Island. No surplus foodstuff is grown, the villagers planting needs often not quite enough but with no really drastic consequences unless there is a prolonged drought, hurricane or something of the sort. Perhaps *Canna edulis* could be tried out by the Buli or school teacher.

Burning is too common a practice often with serious results. Coconut palms, bananas, etc., are often ruined by fires, especially when areas are being cleared for yam planting. If this practice is to continue a condition should be that enough men be present to control and confine the fire. It should be discouraged and the Fijian could help considerably here.

COCONUT.

Like most islands in Lau the palms are not planted and are confined mostly to the narrow strips along the shore. Most of the copra is produced on Ono Levu, Doi and Udui with a little from Mana. None is produced from Yanua and Davura which only have a few trees. Most of the villagers dry their copra on matting made from coconut leaves and placed on the ground; only a few have proper "vata". The palm is used extensively, the trunk and leaf for house building and the nut in food oil, copra and for drinking. The freedom with which they use each others trees, stands in strong contrast to the strictness of a plantation on Taveuni.

There was no sign of *Oryctes rhinoceros* on any of the islands of the group.

ANIMALS.

Pigs.—These are so plentiful that no family in the Nukuni-Lovoni village is without one; a few have 20 odd. The pig fences are inadequate and the pigs roam freely, damaging crops, young coconut palms and kie (Voivoi) near the village. Crops grown near the village are fenced off to keep the pigs out. Crops are planted 2-2½ miles away from the village and villagers have to carry

food this distance. It is perhaps the only village in Lau where food crops are planted relatively far from the village. At Doi and Matokana crops are grown on the outskirts of the village as pigs are fewer.

Cattle.—About 20 on Ono Levu—pasture poor and they eat vaivai (*Serianthes* sp.) to supplement it. Goats are also on Ono Levu and Mana.

The brown medium-sized *field rat* is found on all six islands—the larger *grey rat* (*Kalavo ni valagi*) is only found on Mana and may have been brought there by a ship.

Snakes are found only on Yanua, a brown and a grey type which appear to belong to the same genus or even the same species. Both have a very flattish head and the same type pattern and arrangement of scales. It is peculiar they are found on only one island and though not plentiful are often found early in the mornings among coconut shells from which copra has just been cut.

SAFETY FIRST

Every year people are killed by tractors. Usually the victims are drivers who have become careless, but sometimes they are children. Don't let your child play on a tractor ; and don't forget that it can be a dangerous thing if not handled properly.

Always do things in the correct order and in the proper way. Make sure that the engine is out of gear before you try to start, or the tractor may start and move forward: if it is in a shed it may go through the wall, and if you are in front you may be crushed. Never drive with your feet resting on the clutch or brake pedals, or you will cause undue wear ; and never try to operate a foot clutch while standing on the ground. Power take-off shafts can be very dangerous if not protected by proper guards. Always disengage the drive before you get off the tractor, and take care that you have no loose clothing which might get caught by a rotating shaft and drag you against it.

Be very careful after driving through water, or washing your tractor, for if the brakes get wet they will not hold. The proper procedure is to drive slowly and apply the brakes gently at intervals until they dry out. Brakes on rubber-tyred tractors must be properly adjusted, for if they do not operate evenly the tractor may be swung to one side if you try to stop suddenly. Another danger is in driving with wet and muddy feet or boots, which may slip off the clutch pedal when you are starting, and make the tractor jump forward.

Remember that when you drive on the public road you must give the proper hand signals, and be very careful to make sure that no traffic is coming before you turn across the road.

Steep slopes should never be cultivated, but if you have to take your tractor across a slope, then if it is a row-crop type, adjust the wheels to the widest track-setting, to reduce the risk of rolling over. If you have to climb a very steep slope it is safer to go up backwards to avoid the risk of the front end rearing up.

Look after your tractor, keep it clean, and follow carefully the maker's instructions about oiling and greasing ; they know what is necessary, and they want you to be satisfied.

—R.R.M.

1952 REPRINT PRICE : 1s. 6d.

GARDENING NOTES

Includes notes on INSECT PEST CONTROL and PLANT DISEASES

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Wet padi, transplanted—

		£	s.	d.
Costs	1. Ploughing by bullocks twice 50 hours	4	14	0
	2. Harrowing by bullocks four times 35 hours	3	5	0
	3. Sowing seed bed 12 hours	0	12	0
	4. 30 lb seed paddy	0	16	0
	5. Planting by hand 140 hours	7	0	0
	6. Weeding 220 hours	11	0	0
	7. Harvesting 180 hours	9	0	0
	8. Drying and winnowing 50 hours	2	10	0
	9. Miscellaneous	0	3	0
		£39	0	0
Return	10. 15 cwt. of paddy at £60 per ton	45	0	0

Net return approximately £6 per acre.

NOTES.—(Figures based on Principal Agricultural Station costs, 1951–52, field 15).

1. Bullocks costed at 7s. 6d. a day. Labour costed at 7s. 6d. a day.
5. Planting costs would be less in wetter land—down to 100 hours—£5.
6. Weeding is very variable and would be less if the ground were flooded.
10. £60 per ton on the farm is based on 18s. a tin of 30 lb. The selling price of Fiji rice—14d. per lb—is equivalent to £78 a ton of padi at a milling percentage of 60. (Australian rice, of poorer quality, is selling at 1s. lb).

Mechanisation is of course still incomplete, but it has been proved at Principal Agricultural Station that rice can be grown successfully by preparing the land and drilling the rice by tractor, and weeding and harvesting by hand.

		£	s.	d.
Costs	1. Ploughing 3 hours	1	1	0
	2. Disc harrowing twice 2 hours	0	15	0
	3. Tine harrowing ¾ hours	0	6	0
	4. Drilling 1 hour	0	9	0
	5. 80 lb seed paddy	2	0	0
	6. Hand weeding 150 hours	7	10	0
	7. Hand harvesting and threshing 120 hours	6	0	0
	8. Drying and winnowing 19 hours	1	0	0
	9. Depreciation of implements	1	0	0
		£20	0	0
Return	10. 15 cwt. of paddy at £60 per ton	£45	0	0

Net return approximately £25.

NOTES.—(Figures based on Principal Agricultural Station costs, 1951–52, field 2 B (1)).
Tractor costed at 7s. 6d. per hour (including driver, fuel, etc. and depreciation).

1. Two ploughings often necessary.
4. Includes extra labour.
5. Amount of weeding necessary depends largely on previous crops.
6. Harvesting costs will be reduced this year if the new rice stripper is successful.

—R.R.M.

TRACTOR OPERATING COSTS

A recent analyses of tractor operating costs at Koronivia are set out as under:—

(*a*) FORDSON MAJOR (HALF-TRACKS).

Item.	*Per hour.* s. d.	*Per acre.* (3 *acres per* 8 *hrs.* s. d.
2 f. ploughing—		
Fuel and oil	5 1	13 2
Wages	1 6½	4 0
Depreciation and Maintenance	5 0	13 0
	11 8	30 2

Item.	*Per hour.* s. d.	*Per acre.* (13 *acres per* 8 *hrs.*) s. d.
Disc harrowing—		
Fuel, etc.	5 1	3 2
Wages	1 6½	1 0
Depreciation and Maintenance	5 1	3 1
	11 8	7 3

(*b*) FERGUSON.

	Per hour. s. d.	*Per acre.* (2·4 *acres per* 8 *hrs.*) s. d.
Ploughing—		
Fuel, etc.	2 2	6 6
Wages	1 6½	4 6
Depreciation and Maintenance	5 0	16 0
	8 9	27 0

	Per hour. s. d.	*Per acre.* (8½ *acres per* 8 *hrs.*) s. d.
Disc harrowing—		
Fuel, etc.	2 1	2 0
Wages	1 6½	1 6
Depreciation and Maintenance	5 0	5 0
	8 7	8 6

—R.R.M.

ANIMAL HUSBANDRY . . .

THE USE OF ANTIBIOTICS IN ANIMAL FEEDING

BY W. J. A. PAYNE

One or two local farmers have recently shown an interest in the use of a small quantity of antibiotics in animal feeds as growth promoters. These notes have been compiled in order to inform anyone who is interested what is known in this new field of animal nutrition.

Antibiotic, is the name given to any chemical substance produced by a micro-organism such as a mould or bacteria that is poisonous to other micro-organisms. Thousands of organisms produce substances that exhibit antibiotic activity but the majority are toxic and only a few can be used clinically, amongst these being streptomycin, aureomycin, terramycin, bacitracin, and penicillin. Not all the antibiotics that can be used clinically, exhibit growth promoting properties and the principal ones used at present are aureomycin and procaine penicillin or diamine penicillin.

The discovery of the growth promoting property of antibiotics is very recent. In 1948 workers in an American Pharmaceutical Chemical Company were examining the vitamin content of the residues left after the production of aureomycin. It was found that they were a rich source of vitamin B 12, but that they also contained other substances that stimulated growth. This was later found to be the antibiotic itself. The way in which the antibiotics acts as a growth promoter is not yet understood. Nutritional research during the last decade has shown how important to the animal is the amazing variety of bacterial and protozoal forms of life found in the gut. Antibiotics could act by reducing the number of harmful bacteria in the gut, including those that produce toxic substances or those that compete with more desirable organisms, or by reducing the number of bacteria that compete with the animal itself for essential ingredients of the feed. Recent experiments in Reading, England have shown that the majority of young growing animals may suffer from an almost ubiquitous growth depressing infection, and the antibiotic may be toxic to the organisms causing this infection, as chicks kept in completely sterilised cages grow as fast as chicks in ordinary cages fed antibiotic, and faster than chicks in ordinary cages not fed antibiotic. It is also possible that the antibiotic stimulates unidentified gut organisms to produce new or undiscovered vitamins that act as growth stimulators.

Antibiotics for pigs.—Experiments in both the U.S.A. and Britain have shown that the addition of ¼-1½ oz. of antibiotic to one ton of pig feed increases growth rate but that the addition of ½ oz. per ton would appear to be the most desirable economic level. The growth rate of weaner pigs is increased by 20-25% but as the pigs gain weight the rate of growth slows down and the overall increase in growth rate is about 12%. If the pigs are taken to bacon weight the time of rearing is cut by 10% and the amount of food eaten reduced by 5%. There is also some evidence that the best results of antibiotic feeding are obtained when the pigs are fed on a ration normally low in animal and high in plant protein. This suggests that the feeding of antibiotic might be particularly useful in Fiji where animal protein feeds are so scarce.

Considerable success has been achieved in feeding antibiotic to "runt" pigs or to whole litters that are not thriving.

Antibiotics for chicks.—Chicks fed antibitotic are 20% heavier at six weeks and 8% heavier at 26 weeks of age. There are no differences between adult birds, and hens fed antibiotics as chicks do not come into lay any earlier, do not lay any more eggs, and do not lay heavier eggs. Thus antibiotic feeding is only useful for the table-bird trade and is unlikely to be of any real value in Fiji.

Antibiotics for ruminant animals.—Ruminant animals such as the cow and the goat possess an entirely different type of gut to the pig or to poultry. There is no reason to suppose that feeding antibiotic to an adult ruminant would assist growth and the experi-

mental evidence shows that it may even retard growth by upsetting the micro-organism balance within the gut.

The rumen of young ruminants does not start working for the first two or three weeks of life and it is possible and there is some experimental evidence to suggest that the feeding of antibiotics in the early stage would assist the growth of the young animal. There is also some experimental evidence that feeding an antibiotic may reduce the incidence of "Scouring" in young calves. To summarise, the feeding of antibiotics may be useful to a few commercial pig producers, and to anyone with backyard poultry who is interested in fattening young cockerels, ducks, or turkeys. It may also be useful in calf feeding in this country as "scouring" is so frequent in calves. A limited amount of experimental work on the feeding of antibiotics to weaner pigs and to calves will be done at Sigatoka during the next year and anyone interested in feeding antibiotics to any class of stock should write to the Animal Husbandry Officer, Sigatoka Agricultural Station, or to the Director of Agriculture.

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GOAT HUSBANDRY IN FIJI

A REPORT ON THE RESULTS FROM THE GOAT BREEDING PROJECT AT SIGATOKA FOR THE PERIOD JUNE 1950-JANUARY 1953

BY W. J. A. PAYNE, AND N. S. MILES.

The goat breeding work at Sigatoka is directed towards the improvement of the local goat for meat prodution, as the local demand is for meat and not milk, and any improvement in goat meat production will help to reduce the local demand for imported lamb or mutton. An interim report on the project was published in 1952 (*Payne,* 1952).

The foundation herd at Sigatoka was a miscellaneous collection of Fiji does. These have been crossbred with two imported Angora bucks, and their first-cross progeny. It is hoped that it will be possible to import bucks of other breeds for cross-breeding experiments in the future.

BREEDING POLICY.

The first essential of any breeding programme is close control of the animals. This is difficult in the case of goats, as to date we have been unable to dicover a really efficient goat fence, and the animals have had to be herded.

It has been found that both the doe and buck kids are very precocious. Buck kids that are not required for breeding purposes have been castrated with the elastrater at three weeks of age. Those required for breeding purposes have been isolated from the remainder of the herd at weaning and tethered. Doe kids must be segregated from their dams before a buck is introduced into the herd.

At Sigatoka we have tried two methods of segregating the does that should be served, from those that are not mature. At first we ran three separate herds, a buck herd, a breeding doe herd that included all breeding does over one year of age, and a maiden doe herd that included all does under one year of age and the castrated buck kids. The bucks were introduced into the breeding doe herd twice a year, in November and May. They were raddled on the brisket with different colours, so that we would know what buck served what doe. Unfortunately it was impossible to keep the two doe herds completely separate on open range and some does under one year of age were served by the bucks. Conseqently this system of breeding management was abandoned during 1952. All does and castrated bucks were then run as a single herd during the day and the bucks were tethered. At night the does were drafted into two age groups, those over one year old and those under one year old, and the raddled bucks were placed with the former group. The bucks were managed so that they were working for one week in every three. Theoretically the first system of management is superior, as the doe kids can be weaned at three or four months of age and the breeding does get some rest from suckling if they kid more than once per year. It also allows the bucks to run with the does for the full twenty-four hours and not only at night. We have not yet sufficient experience to say which system is the most efficient, but the use of either will give the local farmers a far greater control of breeding policy than they have ever had in the past.

RESULTS 1950-53.

Kidding Percentage.—Although Fiji does apparently breed all the year round, and theoretically it should be possible to get two crops of kids a year, in practise this does not happen.

Experience at Sigatoka has shown that a Fiji doe kids approximately three times in two years (Table 1), and this is also the experience of goat-keepers in East Africa (Lowe (1943)), Nigeria (Vigo, (1946)). and in Brazil (Rosa e Silva Neto (1948)).

There is insufficient data available at present to analyse the kidding behaviour of the cross-bred Fiji x Angora does.

DIAGRAM 1

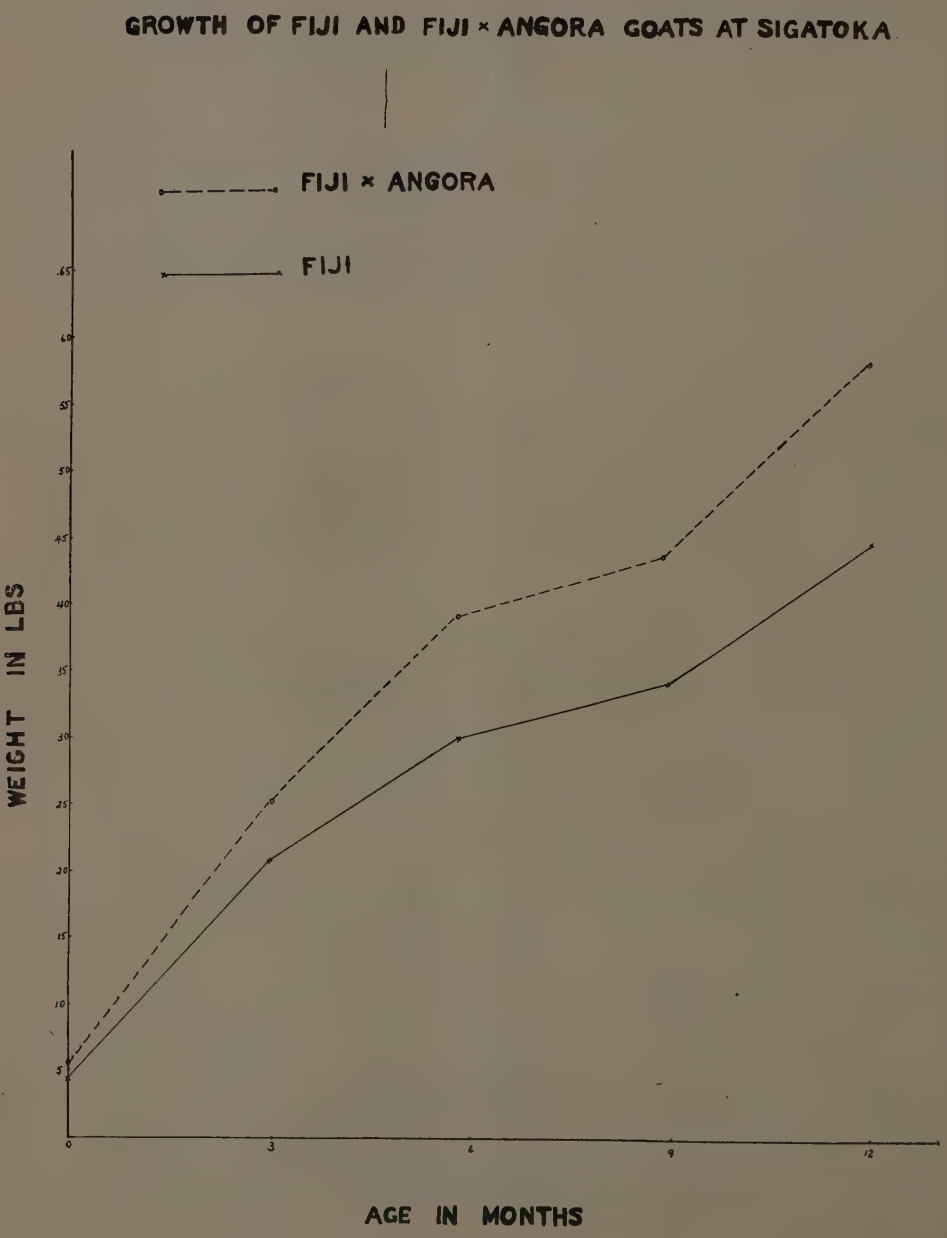

GROWTH OF FIJI AND FIJI × ANGORA GOATS AT SIGATOKA
FIJI × ANGORA
FIJI
WEIGHT IN LBS
65
60
55
50
45
40
35
30
25
20
15
10
5
0
3
6
9
12
AGE IN MONTHS

TABLE 1

KIDDING INTERVAL EXHIBITED BY FIJI DOES.

Kidding interval.	*Days.*	*No. Kiddings*
Mean interval between all kiddings.	262·4	39
Mean interval between first and second kiddings.	276·0	28
Mean interval between second and third kiddings.	225·4	10

Information on kidding percentage, expressed as a percentage of the number of kids born to the number of does in kid, is available for five crops (Table 2).

TABLE 2

KIDDING PERCENTAGES 1950–1952.

(All does, Fiji and cross-bred.)

Date of kidding.	*Type of kid.*	*Kidding percdntage.*
June, 1950 ..	Fiji	160
March, 1951 ..	Fiji	113
August, 1951 ..	Fiji x Angora	137
April, 1952 ..	Fiji x Angora	136
September, 1952	Fiji x Angora	134

A kidding percentage of this type is not a particularly accurate index of productivity, a better index being a kid rearing percentage,

Fig. 1.—A buck crossbred Angora—Fiji kid selected for future breeding work with its doe. This animal was born 28/8/51 and weighed 32 pounds at two months of age.

this is expressed as the number of kids weaned as a percentage of the total number of does run with the buck (Table 3).

TABLE 3

KID REARING PERCENTAGE 1952.

Date of Kidding.	*Type of kid.*	*Kid rearing percentage.*
April, 1952 ..	Fiji x Angora	106
September, 1952	Fiji x Angora	105

Thus if the mean kidding interval was 262 days and 105 kids were weaned for evey 100 does run with the buck the average output of 100 breeding does during the period 1950-53 was 146 kids weaned per annum.

Twinning incidence.—The percentage of twin births to total number of parturitions was 40.5 and 30.0 in Fiji and Fiji x Angora does respectively. In Brazil, Rosa e Silva Neto (1948) states that the twinning percentage in the native Moxotó goat is 40.0.

Growth.—The birth weights and liveweight at three, six, nine and twelve months of age of Fiji and Fiji x Angora goats are shown in Table 4 and in Diagram 1.

TABLE 4

THE BIRTHWEIGHT AND LIVEWEIGHT AT VARIOUS AGES OF FIJI AND FIJI x ANGORA GOATS COMPARED WITH THOSE OF GOATS IN THE UNITED KINGDOM, PLIMPTON (1940).

Type	Birth-weight (lb)	Liveweight (lb)			
		3 months	6 months	9 months	12 months
Fiji	4·6	20·6	28·0	34·5	45·0
Fiji x Angora ..	5·5	25·9	38·3	44·1	58·7
U.K. goats	8·3	....	73·0	....	108·0

The Fiji x Angora crossbreds appear to be heavier at birth and to grow more rapidly up to twelve months of age than Fiji goats, and they do not suffer as large a post-weaning check. This indicates the superiority under the same conditions of nutrition and management of the crossbred goat. (Fig. 1).

If all goat farmers in the Colony adopted a cross-breeding policy there would probably be a substantial increase in goat meat production of the order of twenty to twenty-five per cent. The birthweight and growth of both the Fiji and Fiji x Angora crossbreds does not however compare favourably with that of U.K. goats, but this may not be due to genotype or to the adverse effect of the climate, but to differences in management and feeding. Goats in the U.K. are usually milking types, are not kept on rough grazings and are fed concentrates. These figures do indicate however that both heavier birth weights and increased growth rates are possible.

A comparison of the birth weights and growth of singles and twins, and bucks and does is shown in Table 5 and in Diagram 2. As would be expected buck kids are heavier than doe kids at birth and grow slightly faster. What is remarkable is that twins apparently grow almost as quickly as singles when they are suckling, and slightly faster after they are weaned.

It is obvious that the Fiji does are milking very well on the rough hill grazings and can easily support twins.

TABLE 5

A COMPARISON OF THE BIRTHWEIGHT AND GROWTH OF BUCKS AND DOES, AND TWINS AND SINGLES.

	Birth-weight (lb)	Liveweight (lb)			
		3 months	6 months	9 months	12 months
Singles	5·5	26·7	37·5	42·6	55·6
Twins	5·1	24·1	37·6	43·7	59·7
Bucks	5·6	26·2	38·8	51·0	61·0
Does	5·1	24·4	37·1	42·0	56·7

A statistical analysis of the relationship between the weight of the doe and that of its kid (s) shows that there is a significant correlation in the case of single births but not of twins. The season appears to affect growth, as kids born in May at the end of the wet season are lighter than those born in November at the end of the dry season, and after birth they apparently grow slightly faster (Table 6).

DIAGRAM 2

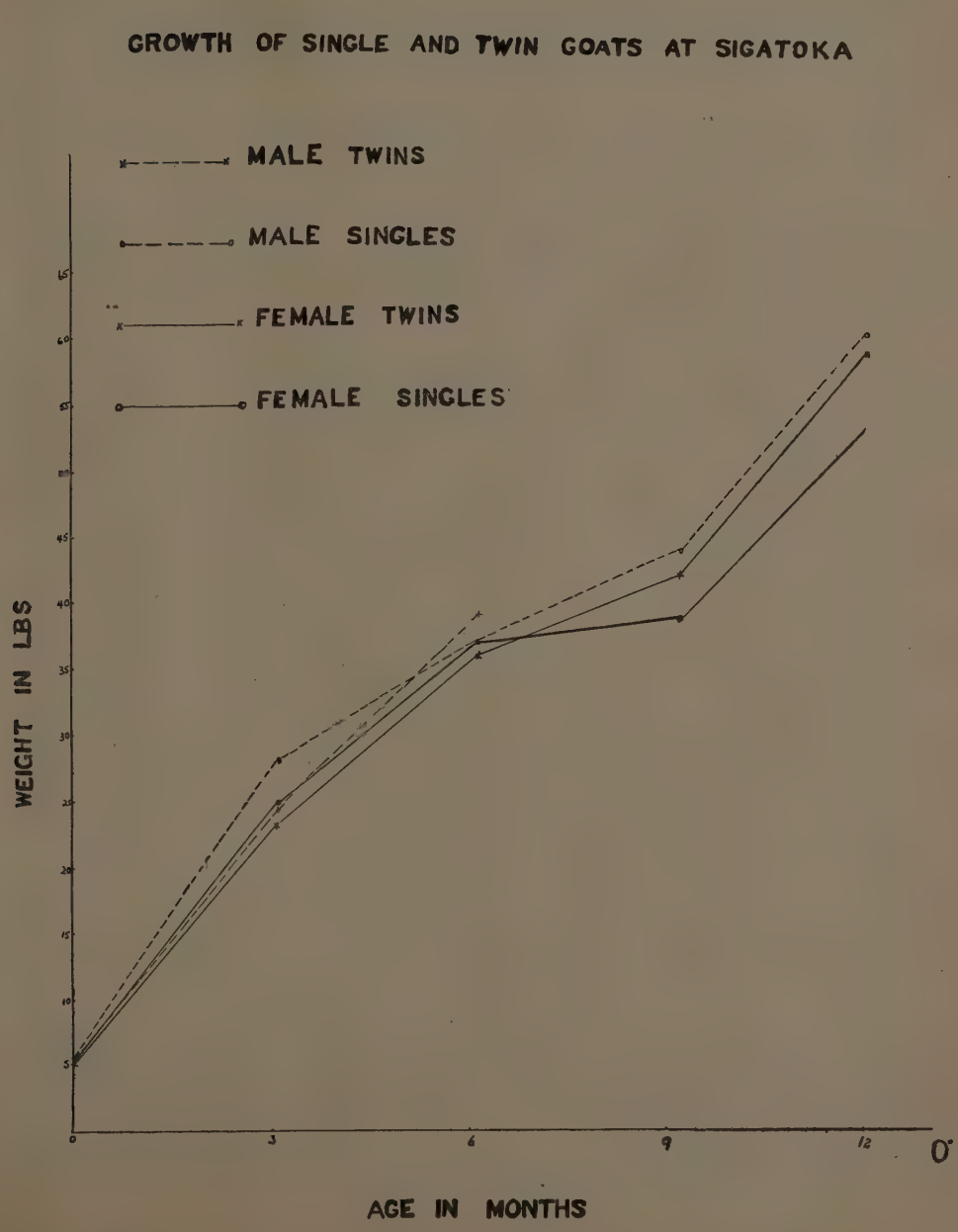

GROWTH OF SINGLE AND TWIN GOATS AT SIGATOKA
MALE TWINS
MALE SINGLES
FEMALE TWINS
FEMALE SINGLES
WEIGHT IN LBS
AGE IN MONTHS
0
3
6
9
12

TABLE 6

THE EFFECT OF SEASON ON THE BIRTHWEIGHT AND GROWTH OF KIDS.

Kids		Birth-weight (lb)	Liveweight (lb)			
Born	Reared		3 months	6 months	9 months	12 months
May	Dry season ..	5·3	25·2	38·8	43·2	57·1
November	Wet season ..	5·5	25·1	36·9	35·0	....

Field observations have shown that the goats dislike rain and will run for shelter as soon as it begins. This suggests that goat rearing should not be encouraged in the wet zone of the Colony.

Health.—All goats are regularly dosed with phenothiazine as described in the interim report (Payne, 1952). The mortality of kids born to purchased does in 1951 was very high (Table, 7), and it is likely that mortality in the Colony's goat herds is generally high. This is also suggested by the fact that although goats breed prolifically and the price of goat meat is high the number of goats in the Colony has not increased during the last two decades. Regular dosing with phenothiazine and good management practises have reduced mortality at Sigatoka to a relatively low level (Table 7). The relatively high mortality in the first week of life suggests that special arrangements should be made during kidding to look after the weak kids. Kids can be successfully reared on undiluted cow's milk fed from a bottle, and six were so reared at Sigatoka during 1952 at a total cost of £1 per kid. The quantity of milk fed was one pound per day for three months.

It is remarkable that the mortality in twins is no higher than in singles and this emphasises the fact that Fiji does are well able to mother and feed twins.

TABLE 7

MORTALITY OF KIDS UP TO SIX MONTHS OF AGE AT SIGATOKA.

Breed	Year	No. births	No. still births	No. deaths				Percentage Total mortality
				0–7 days	1–4 wks.	2–3 mths.	4–6 mths.	
I Singles—								
Fiji	1950	2	....	....	....	....	....	....
Fiji	1951	7	....	4	1	1	....	85·9
Fiji x Angora ..	1951	12	....	1	....	....	....	8·3
Fiji x Angora ..	1952	43	1	2	1	....	....	9·3
II Twins—								
Fiji	1950	6	....	....	....	1	1	33·3
Fiji	1951	2	....	2	....	....	....	100·0
Fiji x Angora ..	1951	14	....	....	....	....	1	7·1
Fiji x Angora ..	1951	46	....	2	1	....	....	6·3

Footrot was troublesome all through the period under review and was not controlled by trimming the feet and applying an ointment, made of vaseline and finely ground copper sulphate. A footrot bath is now under construction.

The incidence of minor abnormalities in the goats, such as misshapen udder, and overshot and undershot jaws, is fairly high. The overshot condition has been introduced by one of the Angora bucks, but it is hoped that it will be possible to cull animals exhibit-

ing these abnormalities as soon as the planned number of breeding does have been obtained and new Angora bucks have been imported.

Feeding.—No further observations have been made on open range. A single goat was however tethered on a pure stand of creeping indigo (*Indigofera endecaphylla*) for some three weeks. This animal grew normally and did not appear to react in any abnormal manner to the diet, although it has been stated that this plant is toxic (Nordfelt and Youngs (1949).

MANAGEMENT.

It has been found that an eight strand wire fence with wooden posts is not goat proof and "cyclone" netting fences are now to be tried. Further experience has demonstrated the utility of the open *bure* shelter. Small portable shelters have been constructed for the tethered bucks, and these have also proved useful.

SUMMARY.

1. Two methods of managing the breeding animals have been described and it is thought that both are superior to methods now in use in Fiji.

2. Fiji does apparently kid three times in two years. The kidding percentage has varied from 113 to 160 during the three years 1950-53, and the average output per annum of 100 breeding does was 146 weaned kids in 1952.

3. The percentage of twin births to total births was 40.5 and 30.0 in the Fiji and Fiji x Angora does respectively.

4. Fiji x Angora kids were heavier at birth and grew more quickly than Fiji kids.

At six months of age the Fiji x Angora kids were 37 per cent heavier and at current prices would sell for an extra seventeen shillings and sixpence each.

5. Twins grow as well as singles and a deliberate selection should be made for twins.

6. There appears to be some seasonal effect on growth, the kids growing more rapidly in the dry season.

7. The total mortality is now quite low, being highest during the first week of life. The mortality of twins is no higher than that of singles.

Footrot in the herd has not been eradicated.

8. It has been found that an eight strand wire fence with wooden posts is not completely goat proof.

REFERENCES.

Lowe, H. J. (1943).—East. Afr. Agric. J., 8, 238.

Nordfeldt, S., and Yonge, O.R. (1949). Hawaii Agr. Expt. Sta. Progress Notes No. 55.

Plimpton, A. A. (1940).—Brit. Goat Soc. Yearb., 24.

Payne, W. J. A. (1952).—Agric. J., Fiji, 23, 25

Rosa e Silva Neto, J. M. da 1948.—Bol. Secret. Agric. Industr. Com., Permanbuco 15.

Vigo, A. H. S. (1946).—Farm. and For., 7, 119.

ECONOMIC BOTANY . . .

PLANT INTRODUCTION AND QUARANTINE STATION, FIJI

BY B. E. V. PARHAM

I. INTRODUCTION.

Since its inception in 1905, the Department of Agriculture, Fiji, has been actively interested in the introduction of economic and ornamental plants and their propagation for distribution within the Colony and to adjacent territories.

Records for the period 1900-1950 are now being compiled for publication, but a brief summary of this work is as follows:—

The first recorded introductions are those of Sir J. B. Thurston and C. H. Knowles—referred to in Annual Reports of the Department of Agriculture for the period.

1. *Musa cavendishii*—var. "Giant Chinese."

2. In 1905, the Botanical Gardens at Suva were established and, for a time, large numbers of plants were introduced. The history and present status of the Gardens with a list of surviving species have been described recently by J. W. Parham[1].

3. In 1906, the Agricultural Station at Nasinu was opened and there a very active programme of plant introduction began: An area of eight acres was set aside for permanent trees; and blocks of rubber, cacao, coffee, citrus, kapok were established[2].

4. In 1928, the Central Agricultural Station was established at Navuso, near Naduruloulou,[3] for the principal purpose of carrying out the coconut breeding work instituted by H. Mareschal[4] and to provide for the experimental study of general crops —rice, bananas, citrus and root crops.

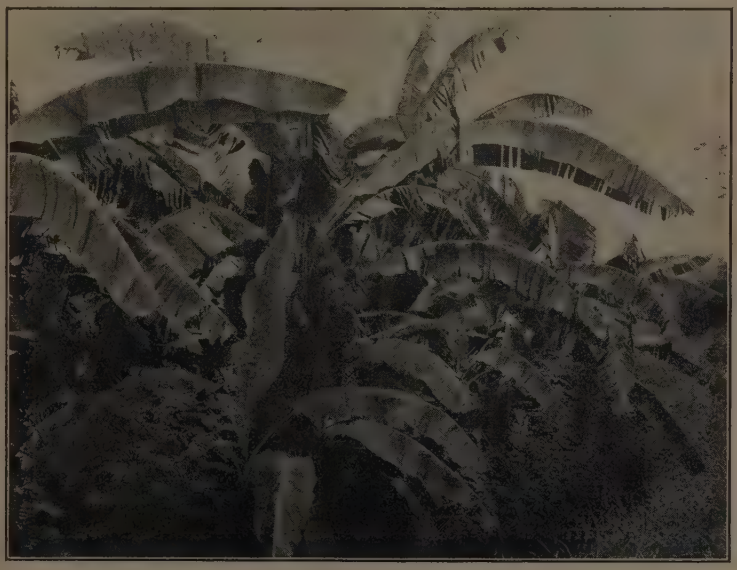
5. In 1936, a plant introduction garden with a small insectary glasshouse for the quarantining of introductions was established on Government-controlled land at Naduruloulou. A fairly large nursery area for the propagation of economic and ornamental plants was developed here ; and in 1933 the first plantings of the Vunibua arboretum were made. On 30th April, 1942, the following directive was issued by the writer to field staff dealing with the establishment and maintenance of the arboretum :—

"VUNIBUA ARBORETUM.

Objects.

1. To grow specimen trees of native and exotic species for observation and study :—

(*a*) to demonstrate their value for shelter or ornamental purposes, and



2. *Musa* hybrid. "I.C. 2."

(*b*) their adaptability to local soils and climate.

2. To establish seed trees for further distribution of proved species in the Colony.

3. To set an example in the utilization of waste hill-land and in the care of trees.

All trees are to be labelled with their name, habitat and year of planting.

Our knowledge of varieties of trees as, e.g. Breadfruit, is incomplete and constant interest and co-operation is necessary, not only to make the collection the best in the Colony, but also to ensure that no important species or variety is missing."

The original vegetation was secondary growth—reeds, *Lantana* and other weeds.

This area has been steadily improved during the years ; and the arboretum now comprises a very valuable collection of indigenous and exotic trees. The relevant data for all these are available.

In 1942, this Station took over the propagation of citrus and all other economic species from Nasinu Station ; and in 1944, at the request of the United States Army au-

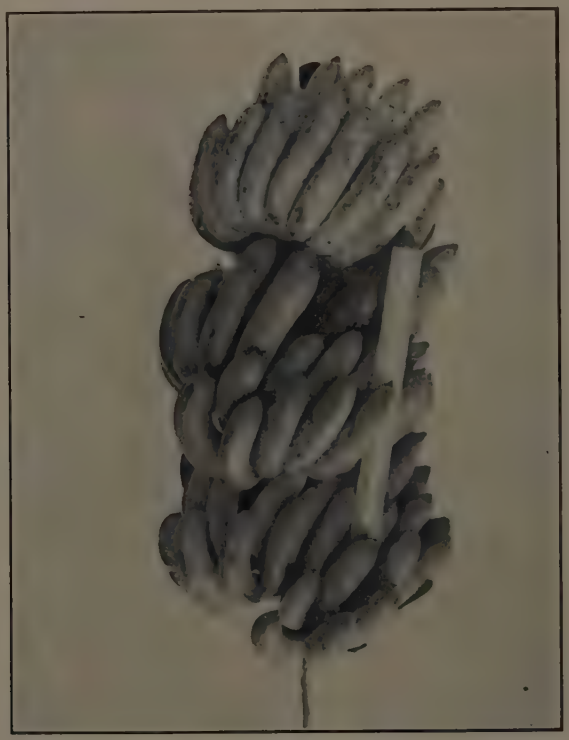
thorities, a large ornamental nursery was established for the purpose of supplying planting material for military cemetries in forward areas.

At the Demonstration Areas, at Waidina in the district of Naitasiri, at Waimaro and Korovou in Tailevu, and at Dobuilevu in Ra were also established blocks of economic trees (timber and fruit).

6. During the past twenty years a very large number of introductions from all parts of the world have been made and some records of these have been published. (5 15).

A few of the most interesting introductions may be noted here :—

Banana Varieties (16) Giant Chinese, Lacatan, Congo, the hybrid I.C.2, and *Musa acuminata* (the seeding species) from



3. Fruit bunch of I.C. 2 hybrid.

Imperial College of Tropical Agriculture Trinidad (Plates 1-7 ; *Manila hemp* (vars. " Tanganon " and " Bungalanon ") from Department of Agriculture, Malaya.

A collection of 80 *Colocasia* types was established and maintained for several years (17).

Budded *Citrus* trees (vars. Jaffa, Washington, Navel, Parson Brown, Lui Gim Gong, Valencia Late).

Green dwarf coconuts (pedigree stock) from Malaya.

Kapok (var. Saigon and Bondoweso) from Java.

Areca Palm (improved selection) from Malaya.

Fodder legumes (*Pueraria, Stylosanthes* (plate 6) *Calopogonium, Centrosema* and *Desmodium* spp.).

Grasses:—*Pennisetum pedicellatum* (2 vars.)—Kavirondo Sorghum (*P. verticelliflorum* var.) Guatemala grass, Rhodes grass and many others (Plates 8-14).

Tonka Bean (*Dipteryx odorata*); Queensland Nut (*Macadamia ternifolia*); Tung Oil (*Aleurites montana and A. fordii*) several lots.

Improved strains of pigeon pea and other pulses,—maize and sweet corn (especially U.S.D.A. 34) and Peanuts (many selections).

Derris elliptica, vars. Changi No. 3, from Singapore and " Amani " from E. Africa ;

4. *Musa cavendishii*—var. " Lacatan."

Many species of ornamental trees not formerly common or available;

Madre-de-cacao (*Gliricidia sepia*) ;

Special selections of Cacao, *Cocos* and Sweet potatoes.

Many fruit trees—Mangosteen, Rambutan; Duku ;

Fibres as Chinese hemp (*Boemeria nivea*) —Jute (*Corchorus*).

Hibiscus spp. and *Sunn hemp* (Crotolaria *juncea*).

Valuable improved selections of Rice : Sonacalif, Ramcajara, B.G. 75 and 79, Demerara Creole, Blue Stick and others.

Large collections of grass and legume seeds for trial and observation have been introduced from time to time and results on their behaviour under local conditions recorded (19).

7. In recent years, distributions to territories in the South Pacific region have been made over a wide area. These have included comprehensive consignments of economic and ornamental species to official and private institutions and individuals in Guadalcanal (Britsh Solomon Islands Protectorate),—to various centres in Gilbert and Ellice Islands Colony, to Pitcairn Island, to both Western and Easterrn Samoa ; to New Hebrides (rice and economic trees); to Rarotonga (coconuts, rice) and to Tonga (coconuts, citrus trees and grasses). Also budded citrus trees and ornamentals have been sent to New Zealand, rice seed to Papua and coconuts to Honolulu for various individuals and for transmission to the trust territories (Ponape). The opportunity to develop these services on an exchange basis is welcomed.

5. *Musa acuminata.*

II. THE NADURULOULOU STATION.

(*a*) *Plant Introduction Services.*

8. In 1945, under the general reorganisation plans (20, 21) of the Department of Agriculture, it was decided to close the Central Agricultural Station, Naduruloulou, and establish a new station at Koronivia some six miles nearer Suva. It was planned to maintain the arboretum and permanent plants of economic bush and tree crops (*Cacao, Coffea,* Tea and *Citrus* and Tung oil) ; but to transfer the nursery and propagation work to the new station. This transfer began in 1948 but was not completed till late 1949.

9. In May 1949, the Research Council, South Pacific Commission, recommended a project under Economic Development (E1 —Plant Introduction Gardens) for the purpose of encouraging and establishing this kind of work in various territories*. In June 1950, the Deputy Chairman, Research Council (Dr. L. M. G. Baas-Becking) visited Fiji and approved the selection of the Naduruloulou area, which the Government of Fiji offered to make available for this purpose and to develop with the assistance of the proposed grant from the South Pacific Commission.

6. *Musa cavendishii*—var. "Congo."

10. *Site of Station*.—The area available comprises a total of 146 acres of Crown Land,—a soil survey of which carried out in 1947 has been reported upon by M. D. ffrench Mullen (24); and the recorded data are available. The area which is surrounded by native-owned land of a similar character, comprises approximately 50 acres of flat and 96 acres of low hill slopes;—climatic conditions are typical of the wet-zone of the Fiji Group. There are several small valleys running into the hills—the area is bounded on the South by a main road (17 miles from Suva) with various access routes already formed—one being metalled for a distance of 12 chains. There is a regular daily bus service to Nausori township and Suva.

Soils.—The soils of the area have been classified into three series, viz :—

1. *The Tailevu Series* (hill)—of a silty clay texture, a small clod to granular structure, compacted—acidic and made up of 3 types.

* The brief description of this Project is given as follows:—"The introduction of economic plants from without the area or transfer from within for study and improvement in special gardens and arboreta looking for improvement saving and availability of such plants for distribution" (23).

2. *The Kasavu Colluvial Series*—from chocolate brown to black at surface to a blue-gray "C" horizon on the zone of permanent saturation. This is a silty clay loam passing from clay to a heavy clay; acidic at the surface—becoming neutral or slightly acidic.

3. *Lower Rewa Alluvial Series*—a small area of silty loam type with a small clod structure—surface. Soil is acidic to less acidic with neutrality at bottom of profile. There is little evidence of erosion and drainage of the area selected for development presents no serious difficulties.

11. *Buildings.*—Already established are various quarters associated with the Research and Extension services of the Department of Agriculture (Entomologist, Weed Control Officer, Agricultural Officer). Offices and Laboratories, at present in use for these services will probably become available when the new agricultural station is fully

7. *Musa cavendishii*—var. "Jaina Leka."

established. Immediately available are quarters for subordinate assistants, concrete store for tools and equipment and office accommodation.

12. *Improvements.*—An area of 50 acres is fenced with concrete posts and barbed wire; and a considerable number of drains have been maintained. Access is good and station paths have been formed.

(*a*) *Developed areas,* totalling 50 acres, are as follows:—

Vunibua arboretum	...	20 acres.
Model farm Section	...	5 acres.
Nursery Block ...	...	5 acres.
Grassland Areas .	...	15 acres.
Drained flat land	...	5 acres.
		50 acres.

(*b*) *Undeveloped areas* comprise colluvial flats and low hill slopes covered with natural grass cover and natural vegetation of trees and shrubs. All of this is readily accessible and can be brought into use as required.

13. *Streams* are the Waidra on the western boundary and the Wai-ni-kai creek running through the east and central portions;—and for permanent water supply purposes the

8. *Stylosanthes gracilis*—" Stylo."

main Rewa River, which is fresh water at this point, is on the southern boundary and within 5 or 6 chains of the Nursery area.

14. Work is now in hand to reconstruct essential facilities and to open up suitable areas for the germination and establishment of new introductions. The labelling of existing species and completion of records is being proceeded with.

III. PLANT QUARANTINE SERVICES.

15. Hitherto quarantine services in the Colony have been limited to the vigilant inspection and control of all plants, seeds and cuttings entering at the main sea and air ports, viz : Suva, Lautoka, Laucala Bay, Nausori and Nadi. The adequate provision for the necessary controls is provided by legislation ; and facilities for fumigation and disinfection have been provided at both Suva and Lautoka—where are also available suitable incinerators for the disposal of dangerous material.

Provision for actual plant quarantine has been inadequate in the past, and has been limited to the very small insectary-glass-house available for the purpose.

In view of the increasing dangers due to modern transportation methods, steps have been taken to stiffen the inspection procedure, to improve the fumigation chambers and to provide for adequate quarantine even of Departmental plant introductions.

16. The Entomologist is stationed at Naduruloulou ; one insectary is available, and another is about to be erected ; suitable areas for isolation plots exist ; and the whole area is most suitably isolated from actual farming areas in the vicinity. It is sheltered from high wind and possesses many small valleys where now crops can be grown apart from other introductions.

17. The importance of a quarantine service cannot be over-emphasised in connection with any project for the introduction of plant material and it is intended that proper attention be devoted to this aspect of the undertaking.

9. *Pennisetum pedicellatum*
Kyasuwa Grass.

IV. THE FIJI DEPARTMENT OF AGRICULTURE CONTRIBUTION.

18. The services already provided and to be developed under this heading and the general programme for plant introduction, quarantine, propagation and distribution, for all Fiji stations, are summarized briefly in the following tabulation :—

A. *Naduruloulou* (Introduction and Quarantine Station) as heretofore described :—

B. *Koronivia* (Principal Agricultural Station).—Facilities and equipment at this Station will continue to be used for selected work in connection with plant introduction and distribution as follows :—

(*a*) Propagation of approved economic plants—*Citrus, Avocado, Cacao* etc., involving special techniques —budding and root stock work.

(*b*) Orchard plots for observation and research of above.

10. *Sorghum verticelliflorum* var. a. Kavirondo sorghum

11. *Tripsacum laxum* Guatemala Grass.

(*c*) Grass and legume introduction research and propagation (Some species to be duplicated at Naduruloulou).

(*d*) Fodder plants—propagation of, for distribution.

(*e*) Research and propagation of food, fibre and other economic field crops.

(*f*) Research on stocks, and varieties (growth, yields and resistance to pests and diseases).

C. *Sigatoka* (Western Agricultural and Livestock Station).—Use of facilities and equipment will be made for selected work with fodder and pasture grasses and legumes, grains and pulses and other crops more suited to drier areas.

D. *Grass and Legume Seed propagation Station*.—This station (46 acres) has been established on land near the Dobuilevu District Farm at Ra, 72 miles from Suva, where

12. *Pennisetum purpureum*
var. b. Elephant Grass
I.C.T.A. selection.

climate and soils are well suited for this purpose : and where certain new introductions can be more successfully grown.

E. *Substations* for the local propagation and distribution of selected economic plants are already operating. They will provide scope for the holding of duplicate material of certain valuable plant species and varieties, to ensure survival in case of floods, hurricanes or other disasters.

V. PROCEDURE AND METHODS.

19. The following procedure is now being followed in accordance with a defined programme : —

(1) *Plant Introduction.*

(*a*) All introductions pass through station for record and decision re distribution, e.g. (*a*) to Stations (*b*) to P.I. and Q. Station (*c*) other:

(*b*) Records kept cover number, date, name, descriptions; quantity; origin; dates received, issued, sown or planted; germination, distribution results and remarks:

(*c*) A register of all introductions is maintained ;

(*d*) Plant lists are being prepared showing species available for distribution.

(2) *Quarantine.*

(*a*) Adequate arrangements for quarantine of any doubtful material involving laboratory investigation, propagation and treatment in isolation and observation over necessary period :

(*b*) Collaboration with Plant Inspectors, Plant Pathologist, Entomologist and Agricultural staff.

13. *Digitaria melangiana*
Woolly-finger Grass.

(3) *Propagation.*

(*a*) Propagation of economic species not for the time being in hand at Koronivia and Sigatoka Agricultural Stations:

(*b*) Propagation and distribution of ornamental species and odd plants (e.g. drugs, perfumes, and species of minor importance) which come to hand from various sources.

(4) *Vunibua Arboretum.*

(*a*) Steps have been taken to maintain and develop the arboretum, all trees are being labelled with name, date of planting and origin:

(*b*) Existing observation plots—*Aleurites, Cacao, Citrus, Coffea, Camellia* (Tea), *Cocos* are being developed and new introductions established:

(*c*) Associated with Curator's quarters are many valuable single specimens of indigenous and exotic trees from which seeds may be obtained as required.

14. *Musa sapientum*
var. " Gros Michel."

15. *Musa cavendishii*
Var. " Veimama."

(5) *Botanical Gardens.*

(*a*) Long range plans for development of suitable area as Colonial Botanic Gardens with attention to both indigenous and exotic plants are under consideration.

(6) *Co-operation.*

(*a*) At all times programme is being followed in close collaboration with other Departmental staff, and there is complete collaboration with the officers of the South Pacific Commission Research Council concerned in the exchange of information and material:

(*b*) There is also continued co-operation with other territories in the South Pacific and the rest of the world in the matter of exchanges of material and information.

CONCLUSION.

20. At this stage no attempt to give a detailed plan of lay-out and activities is attempted; the above being an introductory statement on the subject which will be followed by more complete reports on developments and implementation of the project. Here follows certain lists which indicate that the situation does not lack a background of knowledge and experience from which useful results may be expected.

REFERENCES.

(1) 1948: Parham, J. W.—"Suva Botanical Gardens"—Fiji Agricultural Journal—Vol.

(2) 1905 *et. seq*: Knowles, C. H. *et al.*—"Annual Reports of Department of Agriculture, Fiji"—1905-1933. (Lists of introductions are here to be found).

(3) 1947: Parham, B. E. V.,—"Central Agricultural Station —Nadurulou'ou"—Agric. Journal, Fiji, Volume 18, No. 2.

(4) 1928: Mareschal, H.—"Observations and Preliminary Experiments on the Coconut Palm with a view to developing improved seed-nuts from Fiji"—ibid: Vol. 1 No. 2, 16.

(5) 1931: "Seeds for Distribution"—Ibid.—Vol. 4 No. 2, 87.

(6) 1939: Parham, B. E. V.,—"List of Plants introduced to Fiji by R. B. Howard and W. L. Wallace". Ibid. Vol. 10, No. 4, 112.

(7) 1941: (*a*) "Plants and Seeds List, Nasinu".—Ibid. Vol. 12 No. 2, 56.
1941: (*b*) C. Harvey.—"Plant and Seed Introductions". Ibid.: Vol. 12 No. 4, 114.

(8) 1943: "Supplies of Chaulmoogra Seeds for Planting"—Ibid, Vol. 14, No. 4, 103.

(9) 1944: "Economic and ornamental plants for sale."—Ibid, Vol. 15 No. 1, 3.

(10) 1944: Parham, B. E. V.—"Plant Introductions, 1933-43" Ibid. Vol. 15 No. 4, 94.

(11) 1945: Parham, B. E. V.—"Plant Distribution List."—Ibid. Vol. 16, No. 1, 17-21.

(12) 1945: Surridge, H. R.—"Importation of Plants from Overseas"—Ibid. Vol. 16, No. 3, 66.

(13) 1946: Parham, B. E. V.—"Plant Distribution"—Ibid. Vol. 17 No. 4, 92.

(14) 1947: Parham, B. E. V.—"Recent Plant Introductions" —Ibid., Vol. 18 No. 3, 77.

(15) 1947: Parham, B. E. V.—"Marram grass", Ibid. 80.

(16) 1938: Parham, B. E. V.—"New Banana Varieties for —Fiji Agricultural Journal, Vol. 9, No. 2, 12-14.

(17) 1941: Parham, B. E. V.—"Dalo Varieties from Rotuma Island"—Ibid. Vol. 12 No. 2, 51.

(18) 1946: Parham, B. E. V.—"New Fodder Crops for Fiji", Ibid., Vol. 17, No. 4, 113.

(19) 1934: Surrdige, H. R. and Parham, B. E. V.—"Annual Bulletin of Divisional Reports"—Department of Agriculture, Fijo for year, 1933."

(20) 1944: Shephard, C. Y.—"Report on Agricultural Policy Fiji and Western Pacific High Commission Territories", C.P. 24.

(21) 1945: Patterson, D. D. and Dodds, K. S.—Recommendations for the "Re-organisation and effective operation of the Department of the Department of Agriculture, Fiji", C.P. No. 29.

(23) 1949: "S.P.C. Research Council Programme, 1940-1950" —S.P.C. Inf. Circ. No. 2 July.

(24) ffrench-Mullen, M. D.—"Report on the proposed wet-zone station site of Kasavu, District of Naitasiri, Province of Naitasiri". 21st May, 1950 (not published).

ARBORETUM AT WAIDINA.

Demonstration Area.

NADUNA.

On 11th April, 1942, the following trees were growing strongly in the Forest Tree Reserve:—

A. PLANTED.

Canangium odoratum	63,	oil and timber
Gmelina arborea ...	364,	timber
Cedrela odorata ...	27,	timber
Durio zebethinus ...	2,	fruit
Coffea robusta	30,	fruit
Podocarpus vitiensis ...	26,	timber
Melia azedrach ...	3,	timber
Endospermum macrophyllum ...	21,	timber
Persea americana ...	1,	fruit
Musa textilis (*va. Tanganon*)	3,	fibre
Swietenia macrophylla	151,	,,
Tectona grandis ...	9,	,,
Areca catechu	80,	,,

B. OCCURRING NATURALLY.

(indigenous species) mostly of good growth.

Podocarpus affinis	7
Bassia sp. (*Bawaki*)	30
Eugenia sp. (*yasi*)	10
Parinarium laurinum	60
P. insularum	20
(*Mako*)	3
Garcinia pseudoguttifera	18
Tabernaemontana	15
(*Sole*)	8
Pometia pinnata	30
Drautolu	4
Bidra	10
Aleurites moluccana	15
Alstonia sp.	15
Nelitris vitiensis	4
(*Bauka*)	1

AN EVALUATION OF TROPICAL PULSE CROPS

BY NIGEL COSTER

The wide variety of tropical pulse crops suggests that at least some should attain importance in farming systems in Fiji. As legumes, they claim a place in all rotations ; as food crops, their high protein content makes them a valuable item in a diet too commonly overbalanced with carbohydrates ; where the oil content is high, (groundnuts and soya) they become valuable cash crops ; and lastly they are essential ingredients of concentrated stock rations. Table I *lists* 22 *pulse crops and Table* II *gives the food value of some of them.*

There is much scope for crop improvement in Fiji. In the case of the pulse crops it becomes necessary to assess each individual with the view of selecting from the diversity presented a simple list that would meet local demands. Unfortuantely facts relating to local conditions are not sufficient to permit a fair evaluation of the position. It would appear from Table II, however, that the protein, fat, and carbohydrate composition, is more or less the same for those pulses with a low fat content, and hence large differences in yield would appear to be the most important factor.

Lacking factual information on yields it is only possible to generalise and the yields presented in column 3 of Table 1 although average yields only, are, in most cases, consideraby higher than those obtaining in Fiji. It is probable that selection from strains existing in Fiji and the use of fertilisers, particularly phosphate, will lead to an improvement in yield.

The argument outlined below shows that there is considerable scope for increasing the acreage of pulse crops.

Acreage Under crops, 1951 (*approximated*).

Grain crops	... ...	35,000 acs.
Pulses	... ...	3,500 ,,
Root crops	... ...	31,000 ,,
Sugar Cane	... ...	100,000 ,,

Allowing for some overlapping of grain crops grown on cane land (50 per cent) and root crops grown on grain land (say 50 per cent) the position is as follows:—

17,500	acres growing grain crops.
+15,000	acres growing root crops.
– 3,500	acres land with pulse crops in rotation.
29,000	acres cropped without pulses and almost certainly without green manures.

This does not take into account the 100,000 acres of cane land, but it can be assumed for this land, that the legume phase is or should be green manure crop.

It is unwise, of course, to assume out of hand that 29,000 acres of land cropped without legumes necessarily constitutes bad farming practice. In the case of a large proportion of the land under roots, shifting cultivation accounts for land rejuvenation, and it is also a fact that weed fallows are of some benefit. That there is opportunity, however, of improved farming is particularly apparent since little use is made of organic or artificial fertilisers and 800 tons or more of pulse foodstuffs are imported annually.

The practice of green manuring makes most efficient use of legume crops as soil restorers, but where small peasant farmers dominate the industry it is unlikely that this practice would be the most economical. Pulse crops pay their way and can, under certain circumstances, yield a gross cash return as great as that secured for cane and rice crops.

It would not be fair to overlook the disadvantages of pulse crops in this evaluation. Labour demands are high and the yields not as reliable as those of other cash crops. Pests and diseases, the use of inferior strains, unseasonal weather—all may lead to a partial failure of the crop for which marketing considerations may make the return a dis-

appointing one. As the need becomes greater to substitute capital and labour for land, and as the pulse crops are improved, by introduction and selection ; then may pulse crops begin to play a larger part in the Colony's crop economy.

For a large section of the community the use of pulses as an item of food is no novelty, and for this requirement, dhal and split pea pulses are sufficient. A market exists, too, for those high oil pulse crops. For the Fijians, however, pulse crops as food are unappreciated and little used. There is no doubt that these crops could become an important element in a mixed garden and if it proves unattractive as a dried product some of them at least could be used as green vegetables.

In conclusion the following pulse crops are considered worthy of improvement to play a bigger role than heretofore in local cropping programmes :—

Groundnut ; Soya bean ; Pigeon pea ; Chick pea.

TABLE I

NOMENCLATURE OF TROPICAL PULSE CROPS.

Botanical Names.	*Common Names.*	lb *per acre.*
1. *Archis hypogaea*, L.	Ground Nut—Earth nut. Pea nut. Monkey nut, Goober	1000–1500
2. *Cajanus cajan*, (L) Merr. *Cajanus indicus*, Spreng.	Pigeon Pea—Split pea, Dhal, Dholl, Arhar, Rahar, Red Gram (India). Congo Bean (Africa). No-eye pea (W.I.) Puerto Rican pea	1000–1500
3. *Cicer arietinum* L.	Chick Pea—Gram. Bengal Gram. Spanish peas	600–700
4. *Cyamopsis psoralioides*, DC.	Cluster Bean—Guar bean	
5. *Dolichos lablab*, L.	Bonavist Bean—Lablab bean. Hyacinth bean. Waby bean (W.I.) Seim (Trinidad). Antaque (Mauritius). Egyptian Kidney bean	400–600
6. *Dolichos biflorus*. L.	Horse Gram—Madras gram. Kulthi	400–600
7. *Glycine max*, (L) *Merr. Glycine hispida*, (Moench) Maxim. *Soja max*, (L) Piper.	Soya Bean or Soy Bean	1000–1500
8. *Lathyrus sativus*, L.	Chickling Vetch—Vetchling. Grass pea. Indian pea. Mutter pea. Khesari.	
9. *Lens esculenta*, Moench	Lentil	400–600
10. *Phaseolus aconitifolius*, Jacq.	Moth Bean—Matt bean. Dew bean.	300–500
11. *Phaseolus acutifolius*, A. Gray	Tepary Bean	300–500
12. *Phaseolus angularis*, Wight	Adzuki Bean	300–500
13. *Phaseolus aureus*, Roxb. *Phaseolus radiatus*, L.	Green Gram—Golden gram, Mung (India). Chiroki. Jerusalem pea	300–500
14. *Phaseolus calcaratus*, Roxb.	Rice Bean	300–500
15. *Phaseolus lunatus*, L.	Lima Bean—Madagascar bean. Rangoon bean. Burma bean. Chile bean. Tonga bean. Duffin bean. Cape pea, Patani. Butter bean	300–500
16. *Phaseolus mungo*, L.	Black Gram—Urid, Urdi, Urd (India) Woolly pyrol (W.I.)	300–500
17. *Phaseolus trinervius*, L.	Jerusalem Pea	300–500
18. *Phaseolus vulgaris*, L.	Kidney Bean—*Haricot*. French bean. Ohtenashi bean. Red bean. Salad bean. Sugar bean. Runner bean. String bean. Frijoles. Navy bean	600–700
19. *Pisum sativum*, L.	Green pea—Common pea. Garden pea	400–600
20. *Psophocarpus tetragonolobus*, D.C	Winged Bean—Four-angled bean. Goa bean. Manila bean. Princess bean. Asparagus pea	600–700
21. *Vigna unguiculata*, (L) Walp. (*Vigna catiang Walp.* V. *sinensis* Endl.)	Cow Pea—Catiang pea. Black-yee pea. Marble pea. Tonkin pea. Jerusalem pea. Kaffir bean. China pea (asparagus bean, Yard Long bean or Bodie bean = *V. unguiculata* var. *sesquipedalis*).	400–600
22. *Voandzeia subterranea*, Thou.	Bambarra Ground Nut—Madagascar earth nut. Vandzon, Mozambique, gram, Hluba bean	100–1500

TABLE II

MALAYAN FOOD COMPOSITION TABLE. PERCENTAGE COMPOSITION OF 100 GRAMS UNCOOKED.

(By S. G. WILLIMOTT, Dept. of Agriculture, Federation of Malaya. Scientific Series No. 23, 1949.)

FOODSTUFF	PROXIMATE COMPOSITION						MINERALS			VITAMINS				
	Edible Portion	Water	Protein	Fat	Total Carbohydrate	Calories	Calcium mg. per 100 G.	Phosphorus	Iron	Vitamin A. I.U./100 G	Thiamin mg/100 G	Riboflavin mg/100 G	Niacin mg/100 G	
PULSES.														
Bean, Lima ..	100	12·6	20·7	1·3	61·6	324	68	381	7·5	..	0·60	0·24	2·1	2
„ Mung, Green	100	12·0	22·0	1·0	61·5	325	140	..	8·0	..	0·46	0·34	2·3	..
„ Kidney ..	100	10·0	24·0	2·0	60·0	334	110	..	8·0	..	0·45	0·34	2·3	..
„ Soya ..	100	11·4	35·7	17·5	10·3	302	227	586	8·0	..	1·14	0·31	2·1	..
Chickpea . ..	100	10·6	20·8	4·7	60·9	349	92	375	7·1	..	0·35	0·15	1·4	2
Cowpea	100	10·6	22·9	1·4	61·6	331	80	450	7·8	..	0·83	0·23	2·2	2
Lentil	100	11·7	21·0	0·1	65·2	329	171	210	2·0	90	0·65	0·18	2·8	..

FODDER AND PASTURE GRASS TRIALS AT SIGATOKA

In 1950 *two blocks were laid down at the Agricultural Station, Sigatoka, to compare (in separate experiments) the yields and general performance of four fodder grasses and six pasture grasses which had been selected as giving promise under the conditions of the Sigatoka valley. These projects were completed in* 1952 *and a general account of them is presented.*

FODDER GRASS YIELD TRIAL.

(Project E.B. 12/50).

Four fodder grasses were under trial; these were:—

Elephant grass—(*Pennisetum purpureum* Schum.)

Guatemala grass—(*Tripsacum laxum* Nash.)

Kavirondo sorghum—(*Sorghum verticiflorum* var. Kenya.)

Uba cane—(*Saccharum officinarum* L.)

These were planted out in a 4 x 4 Latin square, each plot being one, one hundred and sixtieth of an acre. Planting took place on 20th March, 1950, towards the end of the rainy season. The elephant grass took well but a number of supplies of the other grasses had to be planted subsequently.

The grasses were cut at average intervals of 6 weeks, the interval being varied according to seasonal growth. All four grasses yielded the greatest bulk during the period December to May and yields were low from June to November. Total yields of each grass for the second year of the experiment (1952) calculated on the basis of tons of green material per acre were as follows:—

Elephant grass .	...	38 tons per acre
Kavirondo sorghum	...	16 „ „
Uba cane	...	15 „ „
Guatemala grass	...	12 „ „

Elephant grass was significantly higher yielding than any of the other grasses but there was no statistical significance in yield between any of the others.

Leaf and stem were weighed separately during the experiment, and results showed that 75 per cent of the weight of elephant grass consisted of leaf as compared with 58 per cent for Kavirondo sorghum, 93 per cent for uba cane and 100 per cent for Guatemala grass. However when cut at 6 weeks intervals most of the stem material was still succulent.

The following conclusions may be drawn from this experiment:—

(1) Elephant grass is easy to establish under Sigatoka valley conditions and gives high and sustained yields of fodder. It is suitable for inclusion as the grass Ley phase of an alternate husbandry system. The manurial requirements of this grass, its soil restorative properties and behaviour in a legume association need further investigation.

(2) The high peak of production of fodder grasses during the summer months, when grazing is usually plentiful, indicates that fodder conservation by means of silage manufacture is necessary to make full use of these grasses.

(3) The end of the rainy season is the wrong time for fodder grass establishment; 5½ months elapsed between planting and the first cut, this unproductive period occurring at a time when available grazing is under pressure and unproductive land cannot well be afforded. Fodder grasses should be established at the commencement of the wet season and the first cut should be delayed as long as possible so as to allow of strong development.

(4) During the dry season the interval between cuts should be extended from 6 to 8 weeks.

(5) Kavirondo sorghum is probably more valuable in an arable rotation as a catch crop for green feed or silage.

PASTURE GRASS YIELD TRIAL.

Project E.B. 11/50.

Six grasses were under trial; these were:—

Para grass—(*Brachiaria mutica* Stapf.)
Little Para grass—(*Urachloa* sp.)
Woolly finger grass—(*Digitaria melangiana*).
Nadi blue grass—(*Dicanthium caricosum* A. Camus).
Dallis grass—(*Paspalum dilatatum* Poir).
Guinea grass—(*Panicum maximum* Jacq.)

These were planted out using root cuttings in a 6 x 6 Latin square, in January, 1950, each plot being one one hundred and sixtieth of an acre. A month later *Desmodium heterophyllum* was interplanted between the grass in each plot.

The grasses were harvested by cutting at intervals determined by the growth of the grasses. In all, 17 cuts were made over a period of 32 months. At the same time sample strips were examined for botanical composition. Some of the more aggresive grasses spread to neighbouring plots and so contributed to the yield from these plots.

The mean yield per cut for each plot over the period of the experiment is given below:—

Woolly finger	35.8 lbs
Para	24.4 ,,
Nadi blue	20.5 ,,
Little Para	16.8 ,,
Guinea	13.8 ,,
Dallis	8.9 ,,

The significant difference (P=0.5) is 4.6 lbs so that woolly finger grass was significantly higher yielding than any of the others while Para grass was superior in this respect to all except Nadi blue grass. The following observations sum up the conclusions arrived at as a result of the trial; it should be noted that these observations refer to Sigatoka conditions, on good arable land.

(1) All the grasses show a marked seasonal variation, the heaviest growth being made from December to May, but this is particularly true of Para and Little Para grass which are not suited to Sigatoka conditions.

(2) Woolly finger grass showed the most even production through the year and this grass might respond to controlled grazing. However little is yet known of its palatability.

(3) Both woolly finger and Nadi blue grasses are very aggressive and both of these strongly invaded neighbouring plots. Woolly finger does not form a tight sward and allows legumes to grow in association; however this characteristic would also permit the growth of weeds. The tight sward formed by Nadi blue grass is useful in the suppression of weeds but it excludes legumes with the exception of some sensitive plant.

(4) Nadi blue grass is a relatively low producer on good soils and does not compensate for this in maintaining yields

through the dry season. Unless cultural treatments to increase its productivity on good soils can be devised its planting should probably be confined to hill lands where its ability to suppress weed growth may be useful.

(5) Guinea grass was not favoured by the conditions of the experiment, being slow to establish and particularly susceptible to invasion by woolly finger and Nadi blue grasses. Once properly established it held its own better but its form of growth does not provide a complete ground cover in pure stand and it is probably more useful in a mixed association.

(6) Dallis grass is slow to establish and low yielding but may be useful as a component of pastures because of its relatively high production in the dry season.

These trials were designed and initiated by W. I. Laing, much of the data was assembled by N. S. Miles and the results were written up by R. N. Coster.

—C.H.

WEEDONE DILUTION RATES

1 in	10	is approximately	2 pints	8	fluid oz.	in 3	gallons water.	
1 in	20	,,	1 pint	4	,,	in 3	,,	
1 in	25	,,	1 pint	0	,,	in 3	,,	(24 pints)
1 in	50	,,	½ pint	0	,,	in 3	,,	
1 in	100	,,	0 pint	5	,,	in 3	,,	(480 fl. oz.)
1 in	150	,,	0 pint	3	,,	in 3	,,	
1 in	200	,,	0 pint	2½	,,	in 3	,,	
1 in	600	,,	0 pint	1	,,	in 4	,,	(640 fl. oz.)
1 in	800	,,	0 pint	1	,,	in 5	,,	
1 in	1,000	,,	0 pint	1	,,	or 1 oz. to 6½	gallons water.	
1 in	2,000	,,	0 pint	½	,,	or ½ oz. to 6½	,,	

COMMON MEASURES.

7 teaspoons .. = 1 fluid ounce
1 pint .. .. = 20 ,, ounces
1 gallon (Imp.) . = 160 ,, ounces
1 American gallon = 0·83 Imperial gallon (4/5 approx).

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ENTOMOLOGY . . .

THE RHINOCEROS BEETLE (ORYCTES RHINOCEROS L.) IN FIJI

B. A. O'CONNOR

1—HISTORY

The Rhinoceros Beetle first entered the South-West Pacific area in 1909, *when it was introduced to Samoa with rubber plants imported from Ceylon. During the last forty years, quarantine measures have been implemented in Fiji with the object of excluding the pest from this Colony, these measures being considerably relaxed during the war period of* 1939-1945. *After the war, the beetle was found to be established in the Bismarck Archipelago, Territory of Papua-New Guinea, and also in the Caroline Islands, north of the equator. In February,* 1952, *it was discovered in Vavau, Tonga, and had evidently been there for some considerable time. Quarantine regulations to deal with this new threat were introduced in Fiji, where it was considered that ships coming from Vavau were a greater menace than those from Apia. The reason for this is that Vavau has a small, landlocked harbour, where ships tie up at a wharf in the infested area, whereas at Apia the vessels anchor well offshore in an open roadstead.*

The occurrence of the beetle in Tonga led to a publicity campaign in Fiji, directed towards familiarizing the public with the appearance of the beetle and its immature stages, with the damage to coconut palm fronds which indicates its presence, with its life-history and habits, and with the possible economic consequences of its establishment in Fiji. An approach was made to the South Pacific Commission with a view to their appointing a research team to work on biological and other control measures, the project to be financed by contributions from interested member countries. No immediate action was taken in this direction.

On February 22, 1953, a living female beetle was found between two tarpaulins covering a hatch of a vessel which had arrived from Apia. On March 7, a living female beetle was found in the house of a Fijian at the village of Suvavou, situated on the shores of Suva harbour, and about three miles by road from the town. On March 10 survey and control work was begun by a team of twenty men, under the supervision of Mr. C. A. Stokes. It was quickly found that the pest occurred up to six miles in a direct line west of Suva, four miles north, and four miles north-east.

It was realized that the most energetic measures were called for to eradicate the pest, or at least control it, and prevent its spread to other islands of the Colony. During the latter half of March, a scheme which involved expenditure of up to £70,000 per annum was put forward by the Department of Agriculture, and tentatively accepted by Government, which provided an initial £14,500 to set the project in motion. When Legislative Council met at the end of April, a bill was passed which imposed a tax of £2 per ton on copra purchased by the Copra Board, and £2 1s. 8d. on copra purchased by millers. Government contributed a sum equal to the amount of the tax. It was estimated that about £12,000 per month would thus be made available. The Rhinoceros Beetle Eradication Board was set up to control the funds raised. This consisted of the Director of Agriculture as chairman, and three private members, representing business and planting interests. The tax was imposed as from June 1, 1953, and was to be reviewed as circumstances warranted.

The South Pacific Commission was requested to treat as urgent the project for research on control of the beetle, and Fiji guaranteed the first year's expenditure, so that there would be no unnecessary delay. The Commission's Plant and Animal Quarantine Officer, Mr. L. J. Dumbleton, put forward a project which envisaged the appointment of two entomologists and a chemist, and in May applications for the two former appointments were invited.

2—PROGRESS OF THE LOCAL CONTROL CAMPAIGN.

The control measures adopted were mainly those used elsewhere, namely destruction of breeding places, use of compost heaps as traps and collection and destruction of all stages of the beetle. Traps made of split coconut logs lying on the ground were not used, as it was thought impracticable to visit them regularly over the area involved. However, split coconut logs, where available, were placed on top of compost heaps. Considerable use was made of B.H.C., which has been found lethal to "white grubs" overseas and specifically to larvæ of the Rhinoceros Beetle in India[1]. Compost heaps were treated with B.H.C. so that larvæ which hatched from eggs laid in the heaps might be killed, the soil under breeding places was treated, and thousands of gallons of B.H.C. spray were applied to large saw-

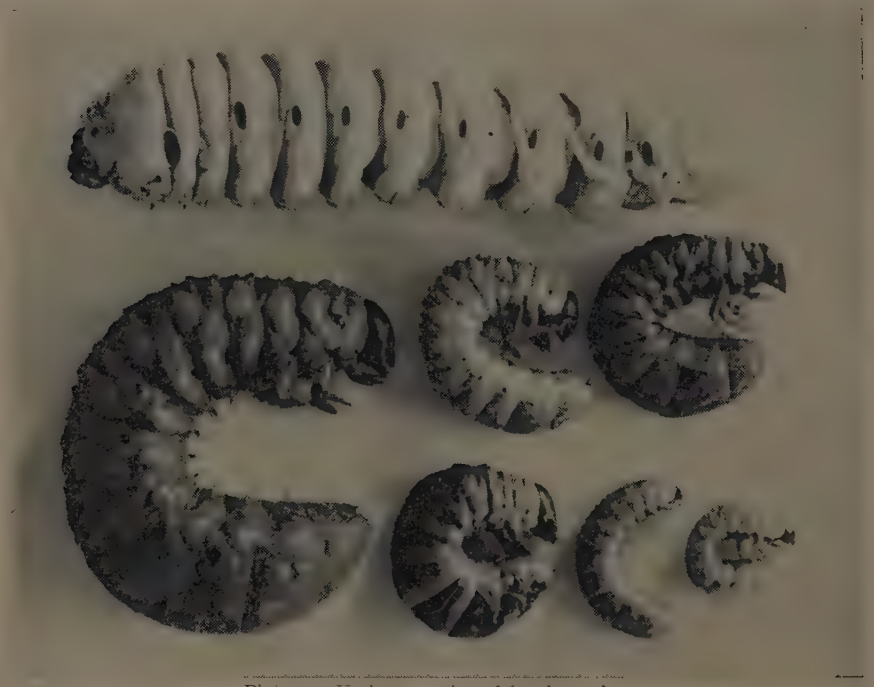

Plate 1.—Various species of beetle grubs.

Natural size.—Rhinoceros Beetle grub in the lower left-hand corner. It has been somewhat extended by injection of a preserving fluid.

Photo—R. WRIGHT.

dust heaps within the infested area. A portable pump designed for fighting forest fires was found very useful for spraying large quantities of insecticidal spray.

One of the main objects of the campaign was to prevent the beetle from reaching other islands of the Fiji Group which are important producers of copra. (Viti Levu makes no significant contribution to the annual output of copra). To this end, quarantine and inspection measures were adopted, including measures to control and restrict the spread of the pest within Viti Levu. Road checking points were established, with the co-operation of the police, at Nausori, on the Rewa River, twelve miles north-east of Suva, and at Navua, 27 miles west of Suva. (The western checking point was for a short time at Wainadoi seventeen miles west of Suva). All vehicular traffic leaving Suva could be examined at these two points.

Inspection of vessels leaving Suva for other islands of the group was carried out, and regulations were gazetted which made it compulsory for owners and occupiers of land within the declared infested area to dispose of potential breeding places.

As time went by, and survey parties discovered evidence of the presence of the beetle further and further afield, modifications had to be made in the plan of campaign. In June the road checking points were dispensed with. In the same month it became evident that a change would have to be made in the disposal of the personnel employed by the Board. Up till then the force of about 200 men had been employed approximately as follows:—

70 men in survey teams, 20 men in compost-making teams, and the remainder in gangs which disposed of actual and potential breeding-places. The extent of the known infestation in June was such that it was obvious that our gangs could not hope to cope with potential breeding-places throughout the infested area. At this stage, fronds damaged by the beetle had been found as far west

Plate 2.—Cage used for experiments with compost.

as Sigatoka, and as far east as Vuci (about a mile east of the Rewa River, near Nausori). Damaged fronds had also been observed as far inland as Naraiyawa. Thus the known east-west distribution was about 70 miles, and the furthest inland distribution about 20 miles from the coast of Viti Levu. Within this area, stages of the life-history of the beetle had been found in a narrow coastal strip about 30 miles long.

A revised plan of campaign was clearly necessary, and it was decided that eradication of the pest was not practicable, and that the objectives should be control of breeding on the island of Viti Levu and prevention of the transport of the beetle to other islands. The whole of Viti Levu, and islands within five miles of the coast of this island were declared to be within the infested area. Thus the regulations regarding destruction of potential breeding places could be enforced throughout the area. More inspectors were appointed, to cope with enforcement of regulations and inspection of shipping. Export of certain root vegetables from Viti Levu was prohibited. Survey teams were despatched to other islands of the group to search for signs of the presence of the beetle.

The number of labourers engaged in destruction of potential breeding places was reduced. Action was contemplated to remove accumulations of sawdust from the vicinity of timber mills, and to prevent future accumulation of sawdust. It was decided to persevere with the construction of compost heaps treated with B.H.C. or Lindane.

3—HOW TO IDENTIFY THE RHINOCEROS BEETLE, ITS GRUBS, AND DAMAGE TO PALMS CAUSED BY THE BEETLE.

(*a*) *The Beetle.*—The adult beetle is a robust insect, dark chocolate in colour, about 1½-1¾ inches long, and ¾ inch wide. Its small head is armed with a stout horn, which is either short and triangular or long and curved. Often the female has a short horn and the male a long one, but this character varies considerably, males being found with a typical female horn, and vice-versa. The best way to distinguish the sexes is by looking at the last segment of the abdomen, just behind the tips of the wing-covers. In the male this is smooth and bare, with only one row of reddish hairs running across the upper portion. In the female it is densely covered with reddish hairs. The under-surface of the abdomen is also much more hairy in the female than in the male, the latter having only one row of hairs on each segment.

There are four species of beetles in Fiji which have a horn on the head and a concavity on the upper surface of the thorax. In all of these, both the horn and the concavity are very much smaller than those of the Rhinoceros Beetle. The beetles themselves are also very much smaller (see Plate 3). The largest of them may have a body-length of 1⅛ inches, and a width of ½ inch at the widest part. The smallest Rhinoceros Beetle seen by the author (a specimen from Samoa) was 1 5/16 inches long and ⅝ inch wide, though specimens as small as this have not been found in Fiji. It should be remembered that once a beetle reaches the adult stage it cannot grow larger, so that a small beetle cannot grow into a larger one. The grub is the growing stage, and upon the adequacy of its nutrition depends the size of the adult beetle.

(*b*) *The Grub.*—This varies greatly in size, according to its stage of development. When first hatched from the egg it is very small, but when fully-grown it may be from 2½ to 3 inches long, and about ¾ inch wide. The grub rests in a curled position, and in this respect resembles the grubs of allied species of beetles belonging to the same and related families of beetles. It has three pairs of legs, a reddish head with powerful jaws, and nine breathing-organs down each side of the body. These latter are very conspicuous in a full-grown grub.

In attempting to identify a suspected Rhinoceros Beetle grub, first eliminate all those which are not curled. (There are some very large straight grubs found in rotting wood). If the specimen in question is a curled grub, its size is a useful character. There are no other curled grubs in Fiji which approach the size of a well-grown Rhinoceros Beetle larva. (See Plate 1). If the specimen is not large enough to be distinguished on the basis of size, the head and the under-surface of the last abdominal segments must be examined. This calls for the use of a magnifying lens. The Rhinoceros Beetle grub has the frontal portion of the head, above the jaws, roughened and pitted, *and* only small, straight spines under the last abdominal segments. These two characters, *in conjunction*, separate it from other curled grubs found in Fiji. Other characters, the presence of any one of which indicates that a specimen is *not* the Rhinoceros Beetle grub are:—

(i) A vertical anal slit, instead of a horizontal one.

(ii) Presence of stout, hooked or flattened spines under the last abdominal segments.

(iii) A smooth, yellowish head, instead of a roughened, reddish one.

Specimens which are suspect should be placed in methylated spirits or formalin and forwarded to the Department of Agriculture.

(*c*) *Damage to palms.*—Only the adult beetle attacks palms, the food of the grubs consisting of decaying vegetable matter. The beetle forces its way down between the bases of the younger fronds and gouges an entrance into the tissue of the midribs. It then bores downwards towards the growing

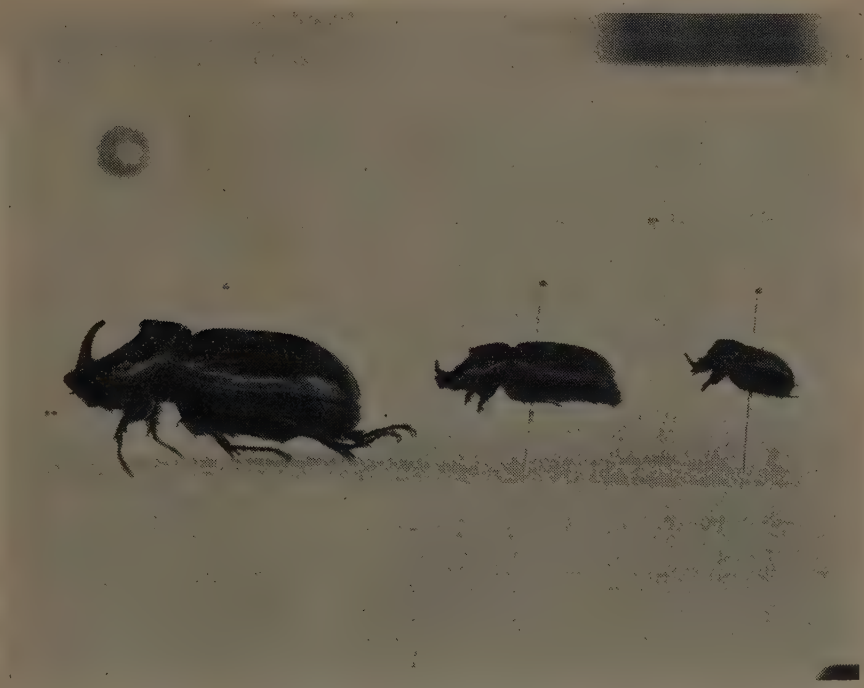

Plate 3.—Side view of three species of beetles with horn on head and concavity on thorax.
Natural size.—Rhinoceros Beetle on left.
Photo—R. WRIGHT.

point of the palm, forcing out fibrous material from the entrance hole. Several beetles may be found in one tunnel, and it seems probable that the growing point can be reached only by the joint efforts of a number of beetles. If the growing point is killed, no more young fronds are produced, and the palm assumes a typical appearance of having older fronds but no young ones. This type of damage has not yet been seen in Fiji, probably because infestation is still light.

As the young fronds of a palm grow, damage done by the beetle becomes apparent. An unmistakable sign of the work of the Rhinoceros Beetle is a large hole through the midrib, (See plate 5) or a large piece excised from the side of the midrib. (Some other insects may cause small surface excavations of the midrib, which do not go right through from one surface to the other). Where the tightly-folded leaflets of a young frond have been chewed, a triangular excision is seen in the frond when it opens out, and usually an irregular chewing mark on the midrib at the apex of the triangle. The midrib may be eaten right through, so that the upper portion of the frond is missing.

Some marking of fronds may be caused by agencies other than the Rhinoceros Beetle. These are as follows:—

(i) Fronds cut off by a knife or eaten off by stock. When this has happened, both leaflets and midrib show a clean, straight cut. The Rhinoceros Beetle leaves a curved or irregular cut on the leaflets, which, when pressed close together, show that they have been bored, and the midrib has an irregular chewing mark.

(ii) Other insects bore through the young, closed leaflets on occasion, but the resulting holes in the opened leaflets are far too small to have been caused by a beetle as large as the Rhinoceros Beetle.

(iii) There appears to be a disease which sometimes attacks the folded fronds, causing triangular excisions or cut-off fronds when they unfold. In this case, the broken ends of the leaflets have a frayed appearance.

4—LOCAL RESEARCH ON CONTROL MEASURES.

The known methods of control of the Rhinoceros Beetle, such as destruction of potential breeding-places, provision of traps consisting of split coconut logs or compost pits, and collection of adult beetles in palms, still leave considerable room for improvement. It is hoped that biological control methods may be of assistance, but it is as yet a little early to introduce specific parasites of the pest into Fiji. Various predatory beetles which can subsist on other host species as well as the Rhinoceros Beetle have been introduced, and more will be brought in later.

It has long been the opinion of the writer that an effective synthetic lure would represent a big step forward in control methods. This avenue, as well as that of biological control, will be explored by the research team which is to be appointed by the South Pacific Commission. In the meantime, it has been thought worth while to carry out some preliminary work locally, with the object of developing a compost trap which would be more attractive to the beetles than their natural breeding places, and which would contain a dosage of insecticide sufficient to kill beetles which might enter it.

Nirula et al.[1] have shown that a dosage of two ounces of 50% dispersible B.H.C. powder in ten cubic feet of cowdung is sufficient to kill grubs hatching from eggs laid in the compost, and that this effect persists for several months. Moreover, this dosage of B.H.C. had no repellent effect on the beetles. Compost traps treated at this rate should be a very useful control measure, especially in countries where the Rhinoceros Beetle has been long established and has a wide distribution. However, it was thought that the situation in Fiji, where we are attempting to achieve a high degree of control, and confinement of the beetle to a small area, posed a somewhat different problem. Hence our objective has been the killing of the adult beetles which enter the compost traps, thus preventing their going further afield and depositing eggs in other breeding places.

To determine the type of insecticide and the rate of application needed to kill adult beetles, wire-gauze cages, 9″ x 9″ x 9″ were used. These were filled with a homogeneous mixture of compost, some being untreated and some treated with Lindane (the purified and odourless form of B.H.C.) B.H.C. or Dieldrin. Ten adult beetles were placed in each cage, with portions of sugar cane as food. After having been left in the cages for a predetermined period, the beetles were transferred to untreated compost, and kept under observation. This experiment was repeated, with similar results on each occasion. Dieldrin appeared to be less effective than B.H.C. and Lindane. Further experiments are to be carried out, using different formulations of the insecticides, with the object of determining the most economical treatment. Results obtained to date are as follows:—(It should be mentioned that preliminary trials with lighter dosages of B.H.C. and Lindane gave less satisfactory results).

B.H.C. 50 % Dispersible Powder, containing 6.5% gamma isomer.—Beetles which were left for 40 hours in compost treated at the rate of one pound per ten cubic feet were all dead or moribund three days later, and all quite dead five days after removal. Actually all the beetles were immobilised at the end of the forty hours' confinement in the treated compost, though several more days passed before they were quite dead. It has been our experience that once a beetle has ben immobilised by B.H.C. or Lindane, it rarely recovers.

Lindane Dispersible Powder, containing 16% gamma isomer.—Beetles were left for 40 hours in compost treated with seven ounces of the powder per ten cubic feet. This gave about the same dosage of the active

gamma isomer as in the B.H.C.-treated compost. Results were similar to those obtained with B.H.C., except that with B.H.C. the insecticidal action appeared to be slightly faster and all of the 20 beetles used were killed, whereas the Lindane treatment killed 19 out of 20.

Dieldrin.—Used at 7 fluid ounces of 18% Emulsifiable Concentrate per 10 cubic feet of compost. Insecticidal action slow, and only 9 out of 20 beetles killed.

Control (*Untreated compost*)—None of the 20 beetles was killed.

As a result of these experiments, it was decided to carry out further trials with B.H.C. and Lindane, but first it was necessary to find a type of compost which would be attractive to the beetles. A large cage was therefore constructed, consisting of a framework of half-inch piping covered by galvanised netting of $\frac{1}{4}$" mesh. (See Plate 2). The dimensions of the cage were 15 feet

Plate 4.—The Rhinoceros Beetle and other species of beetles which have been confused with it.
Natural size.—Rhinoceros Beetles at top left (male) and top right (female).
Photo—R. WRIGHT.

by 9 feet by 7 feet 6 inches, and it rested on a concrete base. Access to the cage was gained by a single door and a pair of wide double doors. The wire mesh extended over the floor of the cage, as well as over the top and sides. Food for the beetles was provided by two young palms, which were placed in drums and had the fronds cut short so that they would fit in the cage. Eight drums containing compost were placed in the

cage, each drum resting on a flat sheet of galvanised iron, three feet square. The drums were about 20 inches in diameter and one foot high, open at the top, and with openings about six inches wide and 1½ inches deep cut at intervals around the lower edge, to allow free access for the beetles. In the drums were placed two untreated and six treated lots of compost, and up to 100 beetles (50 male and 50 female) were liberated in the cage. Each morning a count was made of the beetles caught in each drum. The drums were then moved to new positions, so that each drum had occupied each position in the cage at the end of eight days. The position of the drums with respect to one another also varied each day. The beetles were then kept in tins of compost during the day, and liberated again in the cage at dusk. This procedure was followed for thirty-two days. Two of the drums contained untreated compost, one megass, and the others compost with the following materials:—

cowdung, a length of split coconut trunk on top of the compost, half a gallon of molasses, 7 lbs of coconut meal and 7 lbs of meatmeal. Catches of beetles during the 32-day period were as follows:—

Untreated—139 (57 male, 82 female).

Untreated—113 (48 male, 65 female).

Megass—106 (50 male, 56 female).

Molasses—168 (97 male, 71 female).

Split Coconut log—150 (73 male, 77 female).

Cowdung—148 (66 male, 82 female).

Coconut Meal—256 (132 male, 124 female).

Meat Meal—281 (141 male, 140 female).

The megass was used unmixed with compost. It might have been better to have tried it mixed with compost.

The next step was to determine whether beetles would readily enter compost treated with insecticides. It was decided to use sawdust as the basis of the various mixtures, as this is a readily-available and homogenous material, and the Rhinoceros Beetle is known to breed in sawdust dumps. One drum containing ordinary compost was included in the trial, as a comparison with the sawdust mixtures. This experiment was largely observational, as the heavy mortality of beetles which entered the drums treated with insecticide, and the lack of sufficient beetles to replace those which died prevented a repetition of the technique used in the previous experiment. Also it was desired to leave the beetles undisturbed in the drums treated with insecticide for a sufficient period to receive a lethal dose. The eight drums contained the following:—

Sawdust only, compost only, sawdust with 3½ lbs meat meal, sawdust with 3½ lbs coconut meal, sawdust with 3½ lbs meat meal plus 29.6 grammes of 16% dispersible Lindane powder, sawdust with 3½ lbs meat meal plus 72.8 grammes of 50% dispersible B.H.C. powder, sawdust with coconut meal plus Lindane as above and sawdust with coconut meal plus B.H.C. as above. All the insecticidal treatments equalled a dosage of a little over one ounce of the gamma isomer of B.H.C. per 10 cubic feet of sawdust, or one pound of the 50% B.H.C. dispersible powder per 10 cubic feet. One gallon of water was added to each drum, and further equal quantities of water were added to the drums as the trial progressed.

Every morning dead and dying beetles near the various drums were collected, and every three or four days the sawdust in the drums was searched for dead or dying beetles. Dying beetles were placed in tins of compost, with sugar cane as food, and kept under daily observation. Those from the B.H.C.-treated drums were kept in one tin, and those from the Lindane-treated drums in another. A few beetles which entered sawdust treated with insecticide died in the sawdust, but the great majority emerged from the sawdust when affected by the insecticide, and could be found lying on their back within a few inches of the drum. When drums were searched for beetles, the living beetles were returned to the drums in which they had been found. As fresh supplies of beetles became available, they were liberated in the cage. The position of the drums was changed regularly, as in the previous experiment. A point of interest regarding the use of sawdust is that it appears to remove, to a great extent, the objectionable smell of B.H.C.

Following are the observations made during a period of fifteen days, a total of 117 beetles (74 male, 43 female) having been placed in the cage: (Of the dying beetles which were placed in tins of compost and kept under observation, only 3 males and 2 females survived).

Totals of dead and dying beetles in and near drums treated with Insecticide	Total dead and dying beetles in and near untreated drums, and on floor of cage	Total of beetles remaining alive in untreated drums
No. 9:—14 (10 male 4 female) No. 10:—40 (25 male 15 female) No. 11:—19 (9 male 10 female) No. 12:—18 (10 male 8 female)	10 (8 male, 2 female)	8 (6 male 2 female)

NOTE :—No. 9 :—sawdust, coconut meal and Lindane.
No. 11:—sawdust, meat meal and Lindane.
No. 10 :—sawdust, coconut meal and B.H.C.
No. 12 :—sawdust, meat meal and B.H.C.

The 6 males and 2 females not accounted for by the figures in the table were presumably feeding in the palms provided in the cage. Experience with beetles which had been caged with palms and untreated compost (when experimenting with the attractivenes of various types of compost) showed that about one third of the beetles were dead or dying after fifteen days. Hence 39 of the 117 beetles can be assumed to have died of natural causes. Ten of these died near untreated drums, or on the floor of the cage, so that if we substract 29 from the total of 91 found in and near treated drums, we have a total of 62. Of these 5 survived, so that a rough estimate of deaths caused by insecticide is 57. However, it is probable that the figure should be higher, because of 95 beetles put in the cage on August 30 and 31, 60 were dead or dying in and near treated drums by September 2.

B.H.C. and Lindane appeared to affect the beetles more quickly when mixed with sawdust than when mixed with compost, possibly because the insecticides were more evenly distributed throughout the sawdust than is possible with compost. Of 67 beetles (31 male 36 female) placed in the cage on the first evening of the experiment, 21 (11 males, 10 females) were found dying near the treated drums on the following morning.

Only a few counts were obtained of the number of beetles which entered the drums containing sawdust only and compost only. As more beetles were found in the compost drum than in the sawdust drum, there seems no reason to believe that sawdust alone has any special attractiveness for the beetles. Sawdust with coconut meal and meat meal attracted more beetles than sawdust only or compost only.

As a result of the findings in the trials described above, it was decided to use treated sawdust in pits as a control measure. Coconut meal was chosen, as it is cheaper and more readily available than meat meal. No doubt copra wastes or fish or animal offal would serve as well. Pits are dug 2′ 6″ square and 1′ 6″ deep, and filled with sawdust and a little topsoil, with which is thoroughly mixed 12 lbs of coconut meal and one pound of 50% B.H.C. dispersible powder in about 8 gallons of water. The proportion of coconut meal to sawdust is only half that used in the second cage trial, but was reduced to cut down the cost. It will probably be possible later on to reduce the cost of the insecticide used by employing formulations which are cheaper per unit of gamma isomer. Work needs to be done also on finding how long the treated sawdust remains attractive and lethal to the beetles.

5—LIFE-HISTORY AND HABITS OF ORYCTES.

No attempt has yet been made to work out in detail the life-history of the beetle. However, a few observations of interest have been made. Regarding longevity of the adults, beetles confined in tins containing

compost and provided with sugar cane as food can live for considerable periods. One male beetle captured in the field has been kept under these conditions for over five months, and is still alive. This does not necessarily mean that similar longevity would occur in the field. Beetles can also survive for a long time without food. One beetle kept in a tin was still alive and active after three weeks without food. Others kept in the large cage spent periods of over three weeks in compost without food. Later, beetles kept in glass jars without food lived as long as three months.

When the experiment to determine the most attractive type of compost was begun in the large cage, it was hoped that some information could be obtained regarding the length of time spent by adult beetles in compost and in the crown of the palm. Fifty males and fifty females were marked by cutting one or two notches in their elytra, using a razor blade. Using ten positions for the notches, i.e., eight around the edges and two in the midline, it is possible to mark 55 individuals of each sex differently, using one or two notches. Each position can be referred to by a letter of the alphabet, and individual beetles can then be recorded by using one or two letters. During the thirty-two days during which the compost drums were examined daily, all beetles found in the compost were recorded. Those not found were assumed to be in the crown of the palm. One assumption was made, namely that an individual beetle which had been liberated in the cage at dusk and was found in compost in the morning had spent the whole night in the compost, and had not visited the crown of the palm to feed. Some support was given to this assumption by the fact that a beetle might be recorded in compost every night for a number of nights, and would then be missing for perhaps a week before being recorded again. Unfortunately, however, the results for individual beetles were vitiated to a great extent by the fact that, unknown to the writer, a number of beetles had entered the soil around the base of one of the potted palms. The soil had been wrapped in sacking, with the erroneous idea that this would prevent entry by the beetles. The actual figures obtained showed that over the 32-day period 40.4% of the beetles were in the palm crown and the remainder in compost. A rough calculation was made to allow for the beetles which remained unrecorded in the soil at the base of the palm, and for those which had been dead a considerable time either in this soil or in the

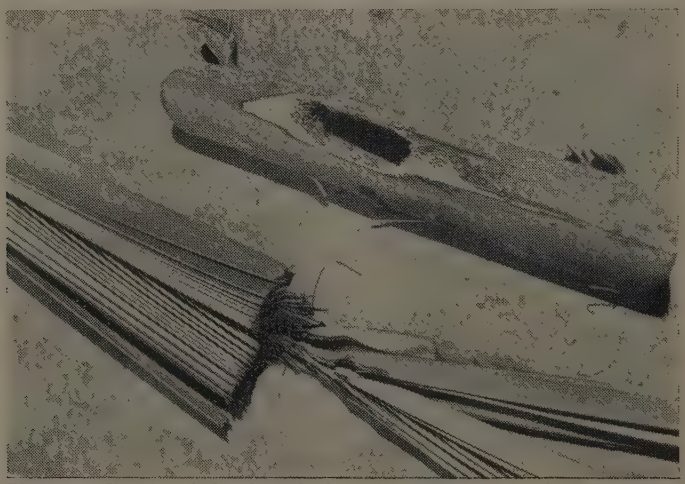

Plate 5.—Showing hole chewed through midrib of frond, and chewing of young, folded frond.

palm. From this calculation an approximate figure of 30% was obtained for the portion of an adult beetle's life which is spent in the palm-crown after the beetle first emerges from the soil. (When the experiment was concluded, and the potted palms were examined, 22 beetles (12 males, 10 females) were found feeding in the palms out of a total of 72, giving a figure of 30.6%). In the field, the proportion of beetles found in palms would be less, perhaps about 25%, because breeding-places would harbour beetles newly or not emerged from the pupal cell.

Individual beetles spent unbroken periods of from one to fourteen days in the palm-crown, and from one to twenty-seven days in compost. These figures apply equally to males and females. On the average, the number of males and females feeding in the palm at one time was approximately equal. Each beetle moved from compost to palm or vice-versa only four or five times on the average during the 32-day period. If this is the case in the field, one would not expect the majority of the beetles to travel a great distance during their adult life.

Observations in the large cage tend to show that prolonged and intense attack by the beetles is necessary to kill a palm directly. (Palms may of course be killed indirectly by disease organisms which attack the wounded tissue). Though each palm in the cage had harboured an average of about eleven beetles during a period of one month, the growing-points of the palms had not been destroyed. The palms were a dwarf variety, about four years old. It appears that the beetles do not eat large quantities of food. This is borne out by observations on beetles kept in tins and provided with sugar cane. A very small quantity of cane appears sufficient to keep a beetle alive, though at times the cane is extensively tunnelled. Beetles have remained quite healthy after long periods without food.

6—INCIDENCE OF ORYCTES IN FIJI.

The distribution of the beetle in Fiji is peculiar. One might have expected high populations of the beetle and a high proportion of damaged palms in the area where the infestation originated, with lower populations and less damage further away from the centre. This was the case at Vavau, Tonga, when the Rhinoceros Beetle was first discovered there. However, in Fiji, though there is a central area where a comparatively high proportion of breeding and damage to palms has been found, the nature of the infestation as a whole is scattered, with low populations of the beetle and insignificant damage. In the six months during which the control campaign has been conducted, an average force of over one hundred men has found 817 grubs, 75 pupæ, 142 adults and two batches of eggs. Of these, 402 grubs, 29 pupæ, 79 adults and the two lots of eggs have been found in an area about three miles in diameter, centred two miles north of Suva, around the Tamavua River. It appears likely that the beetle first established itself in this area. Outside this area, beetles, grubs or pupæ have been found in a coastal strip extending five miles east of the centre and 23 miles west. Evidence of damage to palms has been found 20 miles inland from the infested coastal strip, and in an isolated spot in the Sigatoka Valley 60 miles west of the centre. At Viti Levu Bay, 50 miles north, a damaged frond which appears to have been attacked by *Oryctes* has been found, but there is some doubt as to whether *Oryctes* was the culprit. Definite evidence of recent feeding has also been seen 10 miles north-east of the centre, near Nausori. Despite continual surveying of the countryside outside the area where breeding has been found, the limits of the known breeding area have not been extended during the last two months. Hence we have an overall picture of a light and scattered infestation.

7—LOCAL AND INTRODUCED PREDATORS ON ORYCTES.

Jepson's Beetle, *Plaesius javanus*, which was originally introduced to Fiji to control the Banana Weevil Borer, has on several occasions been found in decaying sago logs. In captivity, the beetle will devour quite large grubs of the Rhinoceros Beetle. During a visit to Samoa, Dr. J. L. Gressitt and Mr. H. W. Simmonds[2] observed *Pachylister chinensis*, another introduced beetle of

the family *Histeridae,* to which *P. javanus* belongs, under split coconut logs which had been placed on the ground as traps for the Rhinoceros Beetle. In confinement, *Pachylister* fed on young first-instar grubs of *Oryctes*. *Pachylister* occurs in Fiji, where it was originally introduced from Malaya by Mr. Simmonds, who has since found it in compost heaps. Both these beetles could help in controlling *Oryctes*.

During May and June, by courtesy of Mr. N. L. K. Krauss and other members of the entomological staff of the Board of Commissioners of Agriculture and Forestry, Hawaii, shipments of predatory beetles were received from Trinidad. These included 5,000 *Histerids* of the genus *Leionota* (*L. colombiana, L. quadridentata,* and probably a third species) and 125 *Elaterids* of the species *Pyrophorus pellucens*. Of the *Histerids,* 350 were liberated near Nausori and 4,500 in the centre of infestation by *Oryctes* near the Tamavua River. Of the *Elaterids,* 90 were liberated in the Tamavua area. Mr. Krauss states that the *Leionota* spp. are found in decaying coconut logs and banana plants and prey on the larvæ of the Banana Weevil Borer and other weevil larvæ. On their arrival in Fiji a test in the laboratory showed that they would devour a variety of larvæ, including young, first-instar *Oryctes* larvæ and grubs of the Banana Weevil Borer. The beetles have a long adult life, and of 40 kept in the laboratory four are alive after $4\frac{1}{2}$ months.

8—SPRAYING OF TOWN DUMP AND SAWDUST HEAPS.

The refuse dump for the city of Suva is situated almost in the centre of the more heavily infested area, and has always been suspected as an important breeding-place. Nevertheless considerable searching has failed to reveal any breeding there. As the refuse is dumped, it is covered by several inches of sand, which should help to prevent entry of the beetle, but the sides of the dump are exposed. In April, using a fire-fighting pump which emitted 60 gallons of fluid per minute, the edges of the dump were sprayed with 1,200 gallons of water, to which was added 40 lbs of 50% B.H.C. dispersible powder (containing 6.5% gamma isomer of B.H.C.). Large accumulations of sawdust at timber mills in the infested area were sprayed with 3,500 gallons of water containing 100 lbs 50% B.H.C. dispersible powder. Early in August, larvæ, pupæ and adults of the Rhinoceros Beetle were found in one of the sawdust heaps, so that the efficacy of the spraying is very doubtful. Methods of dealing with the dump and the sawdust heaps are under consideration.

9—NOTE ON THE FLIGHT-RANGE OF THE BEETLE.

We are indebted to Mr. T. M. Skerman, Oceanographic Officer aboard H.M.N.Z.S. *Lachlan,* for an observation made at Apia. The *Lachlan* was anchored 750 yards from the nearest point of land, and between 8 p.m. and 9 p.m. three adult Rhinoceros Beetles flew on board. One sent to us was a male.

10—ACKNOWLEDGMENT.

The author is greatly indebted to Mr. R. Wright, of the Public Relations Office, for the excellent photographs of beetles, grubs and cage.

LITERATURE CITED.

(1) Nirula et al.:—"Investigations on the Pests of the Coconut Palm". Parts 1 and 2. "Indian Coconut Journal," Vol. IV, No 1, pp. 5-12 and 34-35, 1950 and Vol. IV, No. 2, pp. 49-56, 1951.

(2) Unpublished Reports by both Dr. Gressitt and Mr. Simmonds.

LAND DEVELOPMENT . . .

DEVELOPMENT OF SCHOOL FARMS IN FIJI

1—NEW DAIRY AT ADI CAKOBAU SCHOOL

BY NORMAN LAMONT

[At the reqeuest of the Deputy Director of Education (Mr. G. Sims) a programme of farm development work at the four main Government schools was instituted late in 1951. In consultation with the Principals, the work was organised by the Senior Agricultural Officer (B. E. V. Parham) and involved the combined efforts of the school farm overseers and labour working in collaboration with the Weed Control and Divisional Field Services of the Department. Substantial assistance was given by the Staff of the Principal Agricultural Station, Koronivia and the Plant Introduction Station, Naduruloulou.

With limited funds available it was necessary to proceed on a long term basis of progressive improvement planned for a period of five years, at each of the farms which comprise a total area of 1,500 acres.

The areas involved were generally speaking either entirely undeveloped or infested with heavy weed growth and in some cases soils and drainage were very poor.

There was consequently a good opportunity to experiment with new methods and materials for weed control and to demonstrate improved farming practices. In June 1951 four members of the Field Staff had been transferred to the posts of Farm Overseer, Education Department, so that the prospects of maintaining the work were favourable. It was considered also that apart from the need to improve food production for the students these farms were excellently placed to serve as examples and demonstration of good farming.

The stages of the plan provide for the demonstration of improved methods for :—

(1) *Land clearing and weed eradication.*
(2) *Drainage, roading and farm sub-division.*
(3) *Fencing construction.*
(4) *Pasture establishment and improvement.*
(5) *Weed control in pastures.*
(6) *Farm buildings.*
(7) *Composting of compound and farm wastes.*
(8) *Terracing for soil conservation.*
(9) *Vegetable gardens and field cultivation of food crops including rice.*
(10) *Orchard establishment and tree planting for shade, firewood, etc.*

Since the areas involved were typical of much undeveloped and unproductive farming land in the Southern Division it is proposed to publish a series of short articles on the work carried out and the results achieved.

In this first article of the series, Mr. Lamont describes the construction of a Milking Shed and Dairy at Adi Cakobau School which will serve as a model for small to medium sized dairy farms elsewhere in the Colony.

The photographs are by Mr. R. Wright of the Public Relations Office. EDITOR.]

Over the past few months a new dairy has been erected for the Adi Cakobau School farm, according to a design prepared by the Fiji Department of Agriculture ; and as this building presents one or two features which are not usual in dairies in Fiji the following notes are recorded.

Considerable attention has been directed overseas during the last few years to improvements in dairy design and equipment, and a modern whole-milk producing dairy in temperate countries may be a most elaborate structure whose gleaming stainless steel fittings and hygienic atmosphere fully warrant the use of the term " milking parlour " instead of the more humble " cow-shed ". It is probable that some of the " parlours " do increase efficiency of milking but one suspects that sometimes they are little more than a part of the dairyman's advertising campaign designed to impress customers with the modernity of his outlook.

Fig. 1.—Adi Cakobau School Dairy—showing bails, milk room and yard. Yard rails are 5" strips of " Niusawa " palm bolted on concrete posts. Note subsidiary tank for supply of rain water, drinking trough and yard drain in foreground.

On the other hand, there are many dairies in Fiji that much more closely approach the other extreme and whose design and construction are not only wasteful of labour but are difficult if not impossible to maintain in a strictly hygienic condition.

At Adi Cakobau School, the aim has been to provide first and foremost a utility building of the ordinary " walk through " bail type but with sufficient refinements of finish to make cleaning easier and consequently more thorough. (Fig. 1) Whole-milk is a food that is appreciated not only by man but also, and particularly as it is drawn from the cow at blood temperature, by disease bacteria which are present at all times in a dusty atmosphere.

GROUND PLAN (Fig. 2).

The main features of the ground plan of the dairy which may be seen in the sketch plan include the following:—

(*a*) *Meal room.*—The first point is the location of the meal room to which access is provided by a narrow passage-way within the

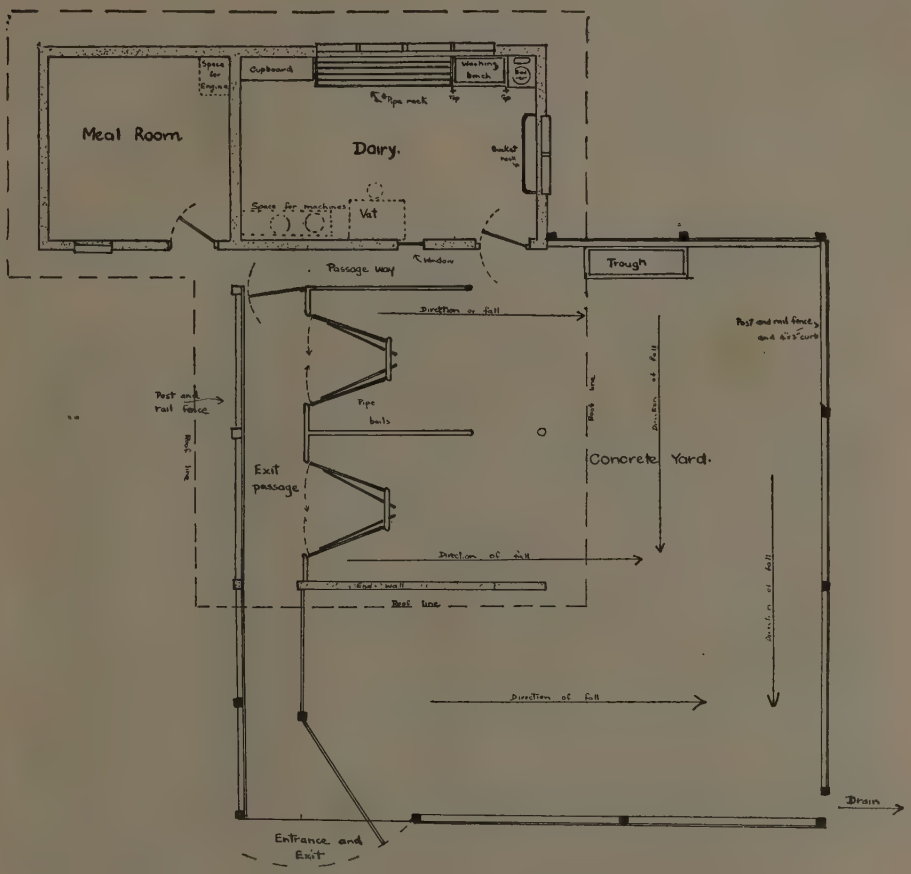

Fig. 2.—Adi Cakobau School Dairy : Ground plan.

bail section, from which it is divided by a pipe rail only. Much more commonly the mealroom is located at the opposite end of the bails from the milkroom and since meal feeding is standard practice in Fiji, there is inevitably a very great deal of traffic during milking from the bails to the meal room, round to the head of the cows to the feed boxes and back to the rear end of the animal again. The other busy traffic route is from the bails to and from the milkroom with buckets of milk, or if machines are used, for the checking of the separator, vat and cooler.

The design used attempts to concentrate this traffic, and at least to obviate the necessity of having to find one's way among cows waiting their turn in the bails ; and will reduce the amount of walking by making it possible to attend to the milk room *en route* to or from the feeding boxes or meal room. To assist further, a small glass window has been built in the milkroom wall so that a glance in passing will often suffice to check up on the vat or separator.

(*b*) *Bails.*—The bails are of a standard design to provide for egress through the side, leaving the permanent end available for feed boxes. The exit passage for the cows also provides access to feeding boxes. A further refinement which would save labour would be some form of automatic meal dispenser. Some dairymen already use these satisfactorily for dry meal, but if molasses is used, their design is more difficult.

Meantime the work of hand feeding has been made less time consuming.

The whole bails area is open front and back, the end wall only being solid to provide more shade. The roof extension is ample to procure shade and also to permit the dairy men to work under cover as much as possible in wet weather. (Fig. 3).

(*c*) *The milk room.*—This has been designed to provide for machine milking if desired. Its " furnishings " consist of pipe draining rack, hot water boiler, pipe bucket rack and cupboard. The tin covered bench beside the boiler can if desired be replaced

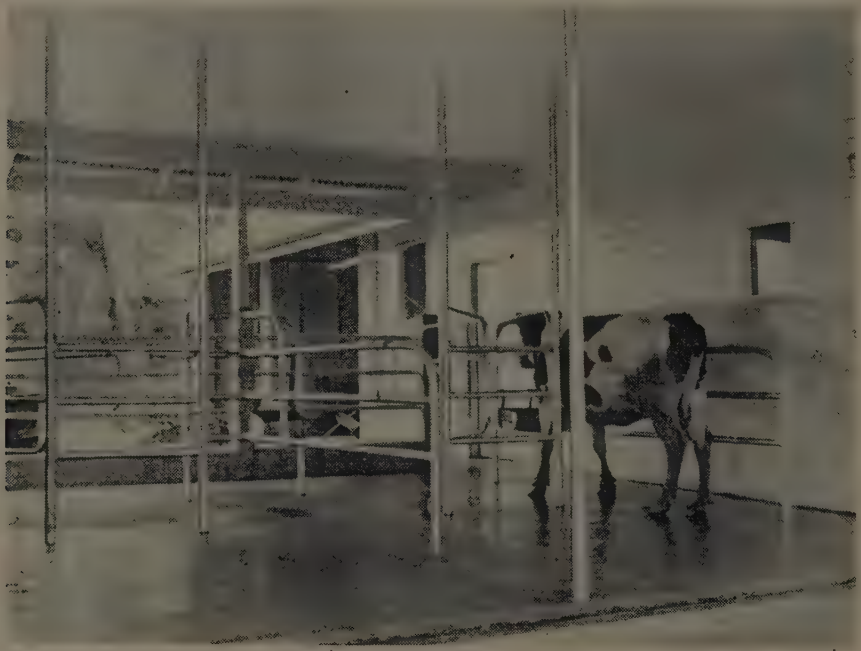

Fig. 3.—The milking shed—showing steel-pipe bails—milk room with observation window at right, meal-room centre and implement shed in back ground.

by a tub and a certain amount of controversy may arise over this point. It is the view of the author that washing can be done more efficiently on the floor under a slowly running tap or, for small separator parts, on a tin covered bench, than it can by dunking all articles into a tub in which the water rapidly becomes a lukewarm mixture of milk and even less desirable impurities. All utensils should be first scrubbed thoroughly under a cold running tap, inside and out ; scrubbed again with a hot soda solution contained in the article, and renewed for each one ; then finally rinsed with very hot water and placed on the rack to drain.

(*d*) *Drainage.*—No square section drains are provided in the milkroom, bails or yard. A fall of 3" or 4" in 10 feet is provided and where opposing falls meet, a shallow " V " results which is ample to carry drainage and which can be easily broomed completely clean. Drainage is led to a solids

trap which will provide useful manure from its regular emptying and the fluid overflow escapes into a storm water ditch. (Fig. 4).

(*e*) *Yard entrance.*—The yard entrance also provides access to an implement shed ; (Fig. 5) but the principle is sound of returning the cows after milking to the same point as they enter the yard. It is much better to have only one entrance to maintain and it is less likely to become a mud wallow in consequence. Whereas some may prefer a holding yard for cows after milking, it is much better that they should return to feed and shade promptly. If a fenced access road is available most cows will soon learn to find their own way back to the nearest open gateway.

Fig. 4.—Yard drain and solids trap fitted with hand pump for removal of liquid manure used for composting and pasture top-dressing.

(*f*) *Water Supply.*—One of the factors determining the site location of the dairy building was the presence near by of a small permanent spring arising in the adjacent hills. A small concrete reservoir was constructed and a pipeline installed to provide water for the dairy and the near-by vegetable gardens and the grazing fields beyond. The building itself was sited on a raised bank levelled by grading and enlarged sufficiently by diverting the stream : it is thus well drained and situated above flood-level.

A supply of rain-water for rinsing and cleaning the milkroom is provided by a 600-gallon tank filled from the roof catchment. (Fig. 1).

MATERIALS AND FINISH.

It cannot be stressed too strongly that milk, particularly at blood heat, is an extremely dangerous commodity. The milk from the School dairy is required to supply a large and growing group of young Fijian girls whose health and well-being are of paramount importance. Accordingly, in every way possible, conditions in the new dairy have been designed to avoid dust-traps and to make the most scrupulous standard of cleanliness easy to attain. All walls are concrete up to 4′ 6″ from floor level and these walls have been steel trowelled to the smoothest possible surface. The smooth plaster has then been treated with a water-glass compound which waterproofs the surface and prevents milk or manure from staining. The milkroom walls are also finished with a glossy paint.

Fig. 5.—Implement shed and meal room with bails and exit passage at right.

All upper walls and ceilings are fully lined and glossy painted and as far as possible sheer lines are maintained to eliminate ledges where dust can collect. No uncovered rafters and joists remain from which dust can sift down into open milk vessels or upon which rats and birds can disport themselves.

The bails have been made of galvanised water pipe bent and welded together as necessary with no wooden members which might, in contact with water and excrements, become rotten and dangerous.

CONCLUSION.

By overseas standards the new Adi Cakobau School dairy is very plain and unadorned and is simply a utility building. Its basic design is efficient but common enough with the exception of the location of the meal room and its access. This may save

only minutes per milking but, in the course of time, minutes are important in an operation that occurs twice on each of 365 days of the year.

Of perhaps greater importance in assisting the hygienic handling of the milk is the attention given to the finish of walls and ceilings and the use, throughout, of materials that will neither rot nor absorb milk or excrement.

The protection of the health of the young people who will consume the milk would be a fair return for a much greater expenditure than has been involved.

DECLARED NOXIOUS WEED

GIANT SENSITIVE—"MIMOSA INVISA"

Giant sensitive was declared a Noxious Weed throughout the Colony on the 26th, January 1945 and the following notes and illustrations have been prepared to assist farmers, planters and pastoralists to recognise this weed should it make an appearance in their districts.

DESCRIPTION.

A spreading shrub with light green bipinnate leaves, light pink globular flowers, light green angular stems six to eight feet long closely armed with curved thorns. Attached to the stem are clusters of short brown twisted seed pods covered with fine spines and containing three or four seeds. The plant is moderately sensitive to touch. (Fig. 1).

DISTRIBUTION.

An American plant but appears to have been accidentally introduced to Fiji from Malaya. It is known to occur in the Sigatoka, Nadi, Tailevu and Naitasiri districts of Viti Levu and on the island of Taveuni.

BOTANICAL AND COMMON NAMES.

The plant is botanically known as *Mimosa invisa*. The general common name is Giant sensitive and the Fijian is *Wagadrogadro levu*.

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NOXIOUS PROPERTIES.

Unpalatable thorny, robust scrambling plant. Should it ever get out of control it would lay waste to thousands of acres of grazing land and make the working of plantations impossible. This is one of the worst potential weeds to have yet been introduced into the Colony.

ERADICATION.

Eradication is difficult and the most practical means of control is by hand pulling of young plants as soon as they appear, every effort must be made to prevent seeding. Hormone-type weedkillers have been used but have not given entirely effective results.

—T. L. MUNE.

Fig. 1.—Giant Sensitive—" Mimosa Invisa ".
A. Mature fruits. B. Flower head and Leaf. C. Stem and immature fruits.

ABSTRACT . . .

USEFULNESS OF THE CASHEW TREE AND NUTS*

A crop which flourishes on a sandy soil of medium fertility in the tropics, where there are wet and dry seasons and a plentiful rainfall.

The tree that bears the nuts belongs to the order Sapindales, and the family Anacardiaceæ, its name being *Anacardium occidentale*. It grows, according to the fertility of the soil, into a large, somewhat upright tree, more than 30 ft. tall, or into a dwarfish shrubby tree on poor waste soils. It flourishes in the warm tropics on a sandy soil of medium fertility, where there are wet and dry seasons, and a rainfall of from 30 to 50 inches per annum, or more. The tree could be of the greatest value for the regeneration of partially exhausted soils, or to give a crop on hillsides which would be too steep for ordinary cultivation. In other words, it is useful in helping to prevent erosion.

A native of Brazil, the cashew tree was spread about the world, and to India in particular, by early Portugese travellers. A small production is maintained to-day in Brazil, Egypt, the West Indies and elsewhere, but India and East Africa are the main producing countries. The United States imported only 2,000 cases of 50lb weight in 1923, but 14 years later she imported 540,000 cases, and to-day takes a great deal more.

Among the leafy foliage the nuts hang down in bunches of twos and threes. They are often cut in India with the aid of a knife on a long stick, because immature nuts may be used in curries, and beverages are made from the swollen fruit stalks. In East Africa the nuts are generally allowed to drop, and they are gathered from the ground. Anyone ignorant of cashew nuts would imagine the fruit to be the swollen leaf stalk, which is about the size of a fat pear, and is a glistening yellowish or reddish colour when grown to full size. Its rather stringy flesh has a sweetly acid juice which is somewhat astringent.

The nut is quite a small thing by comparison, kidney-shaped, and attached at the end of the swollen fruit stalk, as though it were a deformity or an excrescence. It is dark green when ripe, and the inner layer of the hard shell contains an irritant and poisonous liquid from which the useful cashew shell oil is now produced. The cashew kernel also contains an oil, but this, by contrast, is sweet and nutritious. It is used in negligible quantities because uncrushed kernels are of great value for marketing.

The old method of extractng the kernels was to roast the nuts in large pans—a practice still carried out in India at a distance from the factory centre. The pans, containing 30 to 40 nuts, are heated over a bright fire, when a poisonous and acrid smoke is immediately given out. At a critical moment the nuts burst into flame, and the art is in judging when the flames must be quenched. This is done in about a minute, and the nuts are then ready to be cracked open with a small mallet. The process of roasting means a loss of most of the shell-nut liquid containing the shell-oil.

The awkward shape of the nut precludes mechanical decortication, so the modern factory method is to treat the nuts in a solvent of hot oil for a little over a minute, during which the shell-oil is extracted, and the nuts are delivered in a safe and swollen state to hand-labour for opening. A pink internal tissue must then be peeled from the kernels, and the kernels dried, sorted, and packed according to grade in sealed tins containing 25 lb each.

The shell- oil contains alkaloids, resins and other substances from which many derivatives are made. These are used in varnishes and resin manufactures, in cable insulations, in linings of bottle caps, in preventing the gelling of tung oil, and in preserving wood. The crude shell-oil is used for treating fishing nets, for preserving the hulls of wooden boats, and as a termite repellent in timber.

[*Extract from an article in " New Commonwealth Vol. 25 No. 10." By A. E. Haarer. ED.]

For many years the production in South India was from wild growths obtained by planting seed in small openings in bush country, but latterly plantations have been laid down. Indian nuts are harvested from March until May, a small Ceylonese production occurs from April to July, and the nuts from Portuguese East Africa and Tanganyika Territory are imported into India from December to March. In this manner the factories in India are kept going.

The Tanganyika production has grown from 2,000 tons in 1946 to about 10,000 tons last year, in the hands of small African cultivators who are forming themselves into a co-operative organization. East Africa as a whole furnishes about half the kernels that are prepared in India for export.

The tree is so easy to grow in country unsuited to many other export crops that a big production is being planned in Nigeria. Plants may be established by sowing seed at stake, or seeds may be sown in a nursery and the seedlings transplanted into baskets and later planted in the field. The trees begin to flower and yield in 18 months, so they may be planted 20 ft. apart and thinned to 40 ft. as they grow older. An economic yield is obtained in about the fifth year, and full bearing in the tenth year, with a yield of up to 100 lb of nuts per tree.

The trees, the cashew " apples ", and the nuts, vary so much in colour, shape and size in time of maturity and in yield potentials, that selection on a larger scale than has been practised hitherto is essential. The East African nuts are generally smaller in size, though the kernels are often large. The demand for this nut is growing fast, and investigations into its correct environment and its nutritional needs are overdue.

MAIZE RUST

Attention was drawn to the above disease by its serious occurrence on a crop of maize on the Agricultural Station, Sigatoka. It proved to be the true rust *Puccinia maydis*. The disease affects the leaves producing small brown pustules. Older leaves are first affected and when the pustules are numerous the leaves shrivel and dry out. The loss of leaf has an adverse effect on the crop, particularly if the majority of leaves are affected before the crop matures.

2. Infection in the crop at Sigatoka had apparently occurred early in its development and cropping was very seriously reduced. An explanation was sought and found in the presence of an early crop adjacent on the windward side. Mild infection in the earlier crop would have provided a high concentration of spores to infect the later crop. The earlier crop was out of season and had not been unduly affected by rust.

3. In other crops of maize examined rust could be found when the maize was nearing maturity and in mature crops it was abundant on most leaves. However no other instance was seen of serious injury by rust, the disease having mostly developed after the cobs were developed.

4. The normal control method for a rust of a farm crop is the use of resistant varieties. Rust is not a serious disease of maize in Australia excepting for occasional outbreaks in some varieties of sweet corn. It is assumed that the standard varieties and hybrids grown in Australia are resistant to rust. The use of these in Fiji would therefore appear to offer a ready solution to the rust problem but experience in the introduction of these varieties in the past has been so unpromising that it is unlikely that they would be a good substitute for the local maize. It is assumed that the local maize has undergone a long period of natural selection by which it has adapted itself to a number of local factors not at present fully understood.

5. Recommendations for the control of rust are as follows:—

(*a*) Avoid making a succession of plantings in adjacent areas.

(*b*) Plant the crop to mature in the driest period of the year.

A succession of plantings may be quite suitable if the weather is sufficiently cool and dry during the growing period.

—R.B.M.